SECTION V

ALTERNATIVE SOLUTIONS

This section includes alternative solution descriptions, an evaluation of these alternatives and selection of the preferred solution for each ravine. Alternatives were identified with SWM staff after reviewing the results of the hydrologic and hydraulic analyses and geologic investigations described in Section IV.

The general types of solutions considered for each ravine problem include one or a combination of the following: diverting runoff away from the ravine problem area, sedimentation facility at the ravine bottom, channel stabilization, tightlining down the ravine, upstream detention, and others.

The HYD model was used to evaluate the hydrologic effects of various stormwater diversions and detention alternative. The 100-year event was selected as the storm of interest for these simulations. The 100-year event was selected because any potential stormwater diversion must be designed to have adequate capacity for this event.

Each ravine is discussed. Some alternatives include features in two, or all three, ravines. Middle ravine alternatives are referenced by "M", followed by the alternative number. Similarly, the west and east ravine alternatives are designated by "W" and "E", respectively.

A. MIDDLE RAVINE ALTERNATIVES

Eight alternatives were evaluated for the middle ravine.

1. Alternative M-1 - Diverting flow to 84th Avenue NE

This alternative, illustrated on Figure 6, includes diverting all the runoff discharging at the head of the ravine at NE 157th Street to a new 24- and 30-inch-diameter pipe system along Simonds Road NE and 84th Avenue NE. The new pipe system would connect to the existing 24-inch-diameter system that extends north along NE 84th Avenue from NE 169th Street to the Sammamish River.

The HYD model was used to predict the hydrologic affects of this diversion. The estimated peak runoff rates and runoff volumes at the top of the ravine (157th Avenue NE) and the bottom of the ravine with and without the diversion are given on Table 3.

The 100-year flow at the top of the ravine north of NE 157th Street would be reduced from 19.3 to 0 cfs. The peak rates at the bottom of the ravine, where the stream flows enter the pipe drainage system, would be reduced from 30 to 12 cfs, a 60 percent reduction. There would be a corresponding reduction in runoff volumes. The only remaining area tributary to the ravine would include the steep and moderately steep ravine side slopes which consist of undeveloped area and low density single family residences.

Quinault Estates Study

Table 3

Hydrologic Results – Middle Ravine Alternatives

Alternative	Storm Event	24–Hour Rainfall (inches)	Peak Flow at top of ravine (cfs)	Runoff Vol. at top ravine (ac–ft)	Peak Flow at 169th (Node M)(1) (cfs)	Runoff Vol. at 169th (Node M)(1) (ac–ft)
Existing	100–Year 1990 CN	3.53	19.7	13.5	28.8	20.1
M–1	100–Year 1990 CN	3.53	0	0	10.6	6.6
M–4	100–Year 1990 CN	3.53	5	13.5	17	20.1
M–8	100–Year 1990 CN	3.53	10.5	8	20.8	14.7

Notes (1) Node M corresponds to pipe system entrance on Day property

The reduction in peak runoff rates and volumes would significantly reduce the ability of the ravine stream system to transport large quantities of sediment, especially in the upper reaches of the ravine. For the 100-year simulation, the peak flow in the upper two thirds of the ravine would not exceed the current 2-year peak rate. For the 100-year event, the lower third of the ravine would experience flow rates ranging between the current 2- and 10-year events. Peak runoff rates for more frequent events, such as the 2- and 10-year floods, would be similarly reduced. The diversion would also result in making the ravine flows less flashy. The diversion would remove approximately 94 percent of the basin's impervious area.

Because there would continue to be ravine flows entering the pipe system at NE 169th Street, this alternative would include some minor inlet/debris barrier improvements. These improvements would be included to ensure that woody debris does not plug the pipe inlet. A drainage easement would be necessary to install the inlet improvements. The County would also need to decide whether or not to accept maintenance responsibilities for the pipe inlet. Currently, the County only maintains the portion of the pipe system in the NE 169th Street right-of-way.

The diversion system would consist of 760 lineal feet of 30-inch-diameter concrete and 2,400 lineal feet of 24-inch-diameter pipe. The first 700 feet would be placed in a deep trench of up to 12 feet. A more detailed plan and profile of this alternative is illustrated on Figures 7A and 7B. The first 1,100 feet would be concrete to minimize the pipe slope, thereby minimizing the required trench depth. The remainder of the pipe system could be CMP to reduce pipe cost as well as velocities down the steeper slopes along 84th Avenue NE.

Figure 7A shows the diversion pipe along the 84th Avenue NE corridor overlain on a set of preliminary construction drawings developed by the Northshore Utility Sewer District for a new sewer line to be installed in 1994. The alignment for the sewer line is preliminary. Figure 7B shows the diversion pipe along Simonds Road NE, overlayed on the Simonds Road NE construction drawings done in 1977.

The new diversion system would tie into the existing 24-inch-diameter system at NE 169th Street, which flows north discharging to the Sammamish River. The pipe reach with the limiting capacity is the bottom 174 feet which discharges into the Sammamish River. The capacity of this pipe reach ranges between a low of 30 cfs corresponding to a 100-year Sammamish River tailwater elevation and a high of 40 cfs corresponding to normal Sammamish River elevations. The other pipe reaches have capacities in excess of 45 cfs. The 100-year simulated peak flow through this system with Alternative M-1 is 32 cfs. This peak flow with the diversion is slightly higher than the existing capacity of the bottom pipe reach, assuming the 100-year tailwater condition, by 2 cfs.

The 100-year Sammamish River elevations are controlled by the elevations in Lake Washington and the Ballard Locks. This tailwater condition is unlikely to occur at the same time as the peak of the diverted flows because the middle and west ravine basins are small and flashy in comparison to the Sammamish River. If it is determined that the diversion system should be designed based upon a 100-year tailwater condition, the capacity of the bottom pipe reach could be improved by outfitting the upstream manhole of the bottom pipe

reach with a solid locking lid. This would provide a 100-year protection throughout the existing pipe system.

This alternative would lessen the rate of environmental degradation in the middle and west ravines. The significant reduction in peak flows and runoff volumes would allow the middle and west ravine riparian vegetation to recover. The residual middle ravine stream flows would tend to reflect the natural ravine conditions prior to urbanization.

The reduction in stream flows would also reduce the quantity of fine-grained materials that would otherwise deposit in the Sammamish River. This would improve Sammamish River fish habitat.

2. Alternative M-2 - Bank Stabilization / Gradient Reduction

The objective of this alternative would be to make improvements in the ravine channel and banks to reduce erosion and transport of materials to the Quinault Estates drainage system. There are several types of bank stabilization techniques that were initially considered. They include;

- Bed and channel bank armoring
- Short armored steps (or drops) for gradient reduction
- Check dams for debris trapping and sedimentation
- Filling ravine and creating new channel

Bed and channel bank armoring with rock, gabions, wood cribbing, bioengineering techniques, or other methods would not be feasible for the middle ravine because of the unstable nature of the ravine side slopes and their ongoing movement into the channel. It would be extremely difficult and costly to construct bank armoring capable of preventing such movement. An additional difficulty is constructing access through the unstable ravine soils.

Short steps (or drops) constructed of rock or timbers have been used elsewhere to reduce erosion by aggrading the channel and lowering stream velocities. For example, steps of 2 feet every 20 feet would reduce the channel slope from an average of 11 percent to about 2 percent (between steps). While this approach has been effective elsewhere, it would not be appropriate for the middle ravine. Even though lower velocities would reduce the channel bed and bank scour, the unstable nature of the banks would continue to supply materials into the channel and would tend to fill in between steps and low velocity areas. Ultimately, the channel would re-form to its original grade. Again, constructing access up or down the ravine would be very difficult.

Another option considered includes stabilizing the channel with check dams. Check dams could be installed to retain debris, sand, and gravel. They would essentially function the same as the natural debris dams (Photograph 4). They could be constructed small, (4 feet high) or large, (10-15 feet high). While check dams could be effective in trapping materials, they are not appropriate for the middle ravine for several reasons. First, it would be extremely difficult to construct stable, permanent check dams within an unstable ravine. Second, check dam structures create high velocity overtopping flows which generate

considerable downstream scour. In addition, check dams as a long-term solution would require access to remove accumulated sediment and debris. This would require a permanent access road which would be extremely difficult to construct. The above three bank stabilization options were not considered to be feasible solutions.

A fourth option included filling in the ravine bottom so the side slopes would be reduced to a stable angle. That is, by filling the ravine and raising the bottom of the channel 10 to 25 feet, the ravine side slopes could be stabilized. A schematic cross section of this alternative is illustrated on Figure 8.

The raised stream channel would be armored to protect against erosion in the newly placed fill. The channel bottom could include steps (drops) to reduce the velocities. This approach to solving the problem creates the greatest disturbance to the ravine corridor and is the most costly of the alternatives considered.

This alternative would result in the greatest impact to the ravine environment due to the extent of clearing and filling. Significant landscape mitigation would be required. An environmental benefit is the reduction of fine-grained materials that would otherwise deposit in the Sammamish River.

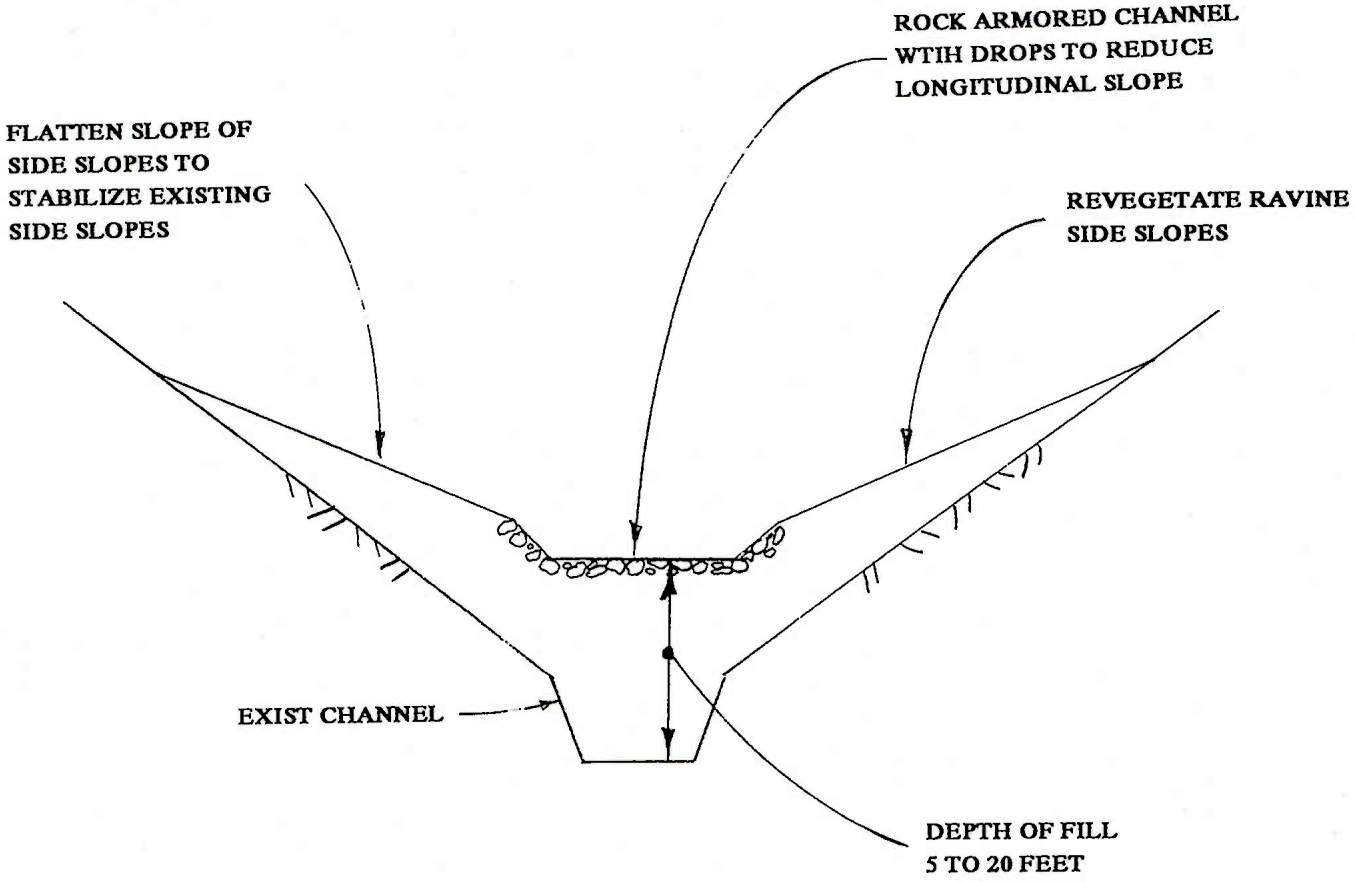
3. Alternative M-3 - Sediment Trap

This alternative includes the construction of a sedimentation facility at the bottom of the ravine. The sedimentation facility would be located on Lots 4, 5, 6, and 7 of Quinault Estates, Division 3) immediately upstream of the existing pipe system entrance. A plan view of this alternative is illustrated on Figure 9. The layout of the sedimentation facility was developed based upon the following:

- Maximize the sediment storage volume using standard construction techniques and 2 horizontal to 1 vertical side slopes.
- Maintain a 10-foot setback from the toe of the south and west slopes, which could be unstable if disturbed.
- Excavate a five-foot-deep pond.
- Include a large debris barrier on the outlet works.
- Create a county access road for maintenance.

The sediment storage volume would be approximately 500 cubic yards. Access would be along the north side of the Day residence and driveway.

The most critical issue of the sediment pond is volume, and whether the pond could accommodate enough material to prevent plugging of the downstream system and subsequent flooding. Determining a pond sediment volume for a specific storm and tying it to a level of protection is impractical. Sophisticated sediment transport models are



SCHEMATIC SECTION
NO SCALE

FIGURE 8
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QUINAULT ESTATES STUDY

MIDDLE RAVINE
ALTERNATIVE M–2

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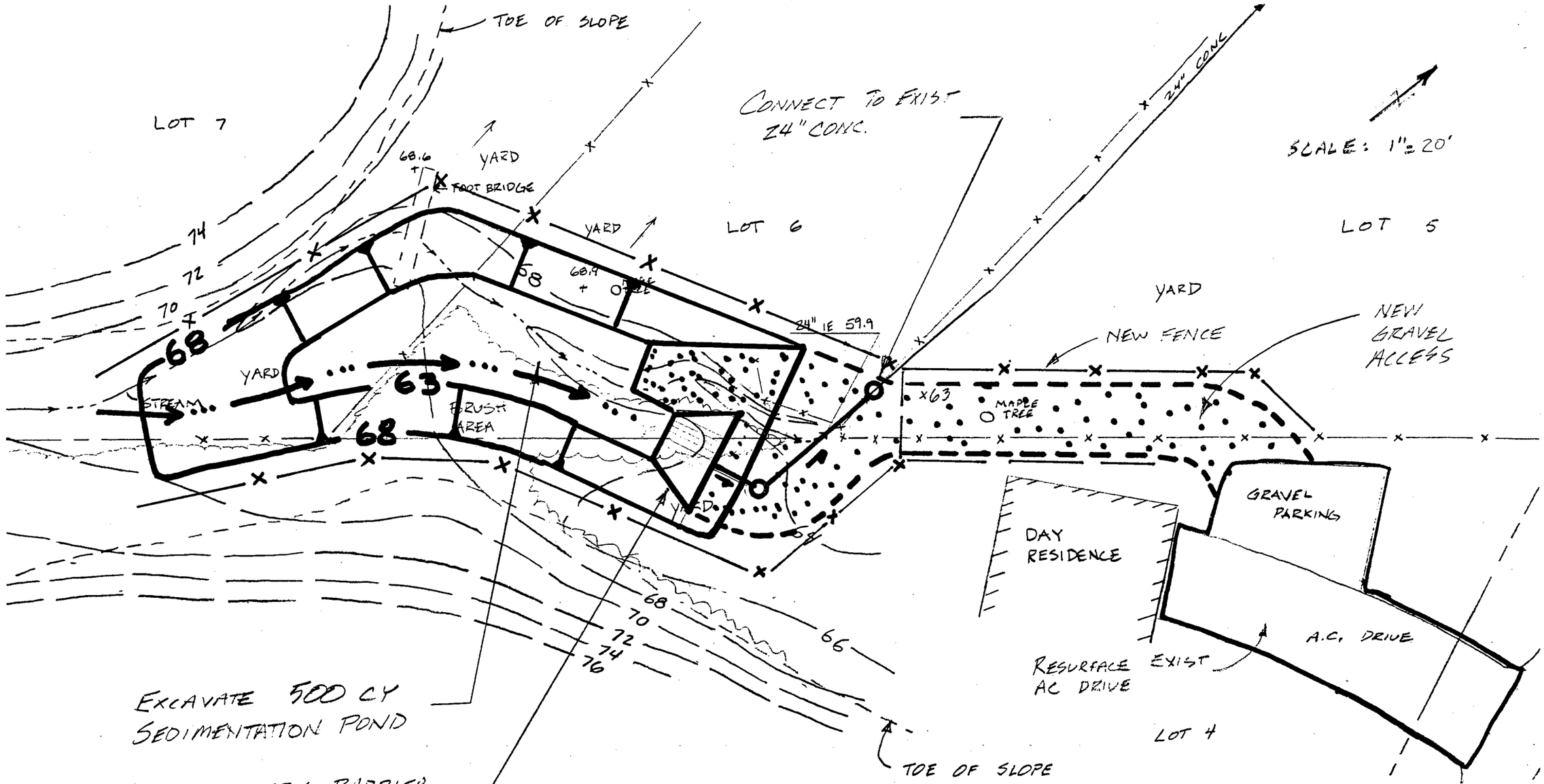

FIGURE 9
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MIDDLE RAVINE
ALTERNATIVE M–3

R.W. BECK
AND ASSOCIATES

available; however, they were developed for low-gradient fluvial systems and would not accurately represent the processes active in the middle ravine.

The volumes of sediment load for the July 13 storm can be used as a guide in evaluating the storage volume needed for an extreme event. As discussed in Section IV, the estimated sediment deposited in the system during the July event was approximately 700 cubic yards of fine-grained material and 300 cubic yards of sand and gravel.

If the 500 cy pond were installed during this event, it would have probably been filled, even though some fine-grained material would have passed through the outlet and downstream pipe system. There is also a possibility that filling of the pond with sediment would have resulted in damaging overflows to Quinault Estates.

Based upon historical observations, some conclusions can be drawn about the frequency of the July 13 event (a 100-year precipitation event) in terms of sediment transport and subsequent flooding. An area resident, Al Nelson, who has lived in the Quinault Estates area below the middle ravine for 26 years at 8442 NE 169th Street, recalls three major events in which the lower floor of his residence was flooded by middle ravine flows that overtopped NE 169th Street. Prior to the July 13 event, the most recent flood occurred in about 1979 (14 years ago). Mr. Nelson said there was less debris and sediment from the 1979 storm.

From this information, it may concluded that flooding resulting from sediment transport and overflow of the pipe system is not particularly uncommon, and may have a likelihood of recurring every 10 to 20 years. Assuming such an overflow event produces a sediment yield similar to the July 13 event, the potential for failure of a 500 cy pond on such a regular basis would be unacceptable.

This alternative would eliminate 150 feet of stream habitat, replacing it with a sediment pond. This would require some environmental mitigation. The pond would reduce the volume of sand and gravel being deposited in the Sammamish River, but it would have less affect on fine-grained materials.

4. Alternative M-4 - Upstream Detention at NE 157th Street

Using upstream detention to reduce peak runoff rates in the middle ravine would reduce erosion rates by reducing stream velocities and flow depths. Immediately north of NE 157th Street, there is a relatively flat undeveloped area which would be a potential site for detention. This site is also a good site because it would collect all flows entering at the top of the ravine.

The HYD model RDFAC was used to estimate the storage volume required to significantly reduce the peak runoff rates entering at the top of the ravine. The current 100-year peak runoff rate is 19.7 cfs. Assuming that the pond would be designed for a target release rate of 5 cfs (approximately 25 percent of the current peak rate), a storage volume of 7.5 ac-ft would be required. The current 100-year flow at the bottom of the ravine would be reduced from 30 cfs to 17 cfs, a 43 percent reduction.

While reducing the peak flows would definitely reduce erosion rates, detention would not reduce overall runoff volumes. Although the peak flows would be reduced, high flows would occur for a longer period of time. While the sediment volume transported through the ravine would be reduced, there would continue to be sufficient flows to transport a large quantity of material which could plug the Quinault Estates drainage system. Therefore, this alternative was not considered as a viable solution to the problem.

5. Alternative M-5 - Tightline in Ravine

The main feature of this alternative is the installation of an 18-inch-diameter HDPE tightline in the bottom of the ravine. The tightline would collect all the flows from the basin above NE 157th Street, convey them in the bottom of the ravine and discharge the runoff to the existing 24-inch-diameter system at the Day residence. The tightline would carry 19.7 cfs for the 100-year event. There would be no remaining stream flow at the top of the ravine and 10 cfs at the bottom of the ravine (due to runoff from within the ravine.)

Reducing the flow in the stream bottom by two-thirds would significantly reduce the sediment and debris transport. Because there would be some flow remaining in the stream, this alternative would also include a natural channel in the ravine and pipe inlet/debris barrier improvements at the bottom of the ravine at the Day residence.

The County has had success in laying the HDPE pipe directly on top of the ground surface next to the stream bottom. The County's prior installations have been shorter and in more stable geologic settings.

The primary difficulty with the middle ravine site would be installing 2,800 linear feet of pipe down the steep ravine. A temporary access road would be needed to allow machinery in the ravine capable of pulling down the long sections of HDPE pipe. The construction of such an access road would be difficult and costly. This construction would also destroy the stream bottom and could further destabilize the hill slopes.

Some other disadvantages of this alternative include:

- A permanent access road for maintenance would be very costly, given the unstable nature of the ravine geology along the pipeline route.

- The County would invest a large cost into this solution, which, if installed on the ground surface, could be subject to vandalism.

For these reasons, this alternative is not preferred.

6. Alternative M-6 - Pipe Inlet Improvements and Additional Sediment Vault

This alternative was initially considered, but rejected because it would not solve the problem. It would include pipe inlet improvements at the bottom of the ravine at the Day residence, including a large debris rack and headwall. The debris rack would prevent woody debris from plugging the pipe entrance. The headwall would provide a greater headwater depth to increase the capacity of the inlet. It also included an additional

sedimentation vault downstream of the existing sediment vault prior to discharging into the Sammamish River. The vault would have a volume of 12 cubic yards. The County installed the second sediment vault in November 1993.

The alternative was dismissed after the volume of sediment deposited during the July 13 event was determined. This volume, 1,000 to 1,200 cubic yards, would plug any type of pipe system entrance unless it was preceded by a large sedimentation facility.

7. Alternative M-7 - Smaller Sediment Facility and Concrete Open Channel to Sammamish River

This alternative was initially considered, but rejected because it would not solve the problem. It included a 50-cubic-yard sediment trap near the current pipe inlet at the bottom of the ravine near the Day residence and a new concrete-lined channel to the Sammamish River.

The alternative was dismissed after the volume of sediment deposited during the July 13 event was determined. The volume of 1,000 to 1,200 cubic yards was estimated to contain 300 cubic yards of sand and gravel. The sand and gravel would quickly fill the small sediment pond, allowing the sand and gravel to enter a concrete channel. The heavier gravel and cobbles would probably settle out in the lower, flatter portions of the concrete channel before reaching the Sammamish River. This would probably cause channel overtopping and flooding.

The Washington State Department of Fisheries would probably not allow this alternative because it promotes the transportation of sediment to the Sammamish River.

8. Alternative M-8 - Divert Runoff from Inglemoor High School

Alternative M-8 would include diversion of runoff from Inglemoor High School to the east ravine and diversion of runoff from Moorland Elementary School and surrounding areas to the west ravine.

This alternative was identified because the two schools make up a significant portion of the middle ravine basin's impervious area and because the two diversions could be made relatively easily with no long pipe systems. A plan of this alternative is illustrated on Figure 10.

The portion of the Inglemoor High School draining to the intersection of 88th Avenue NE and NE 157th Street would be diverted north along the east side of 88th Avenue NE. The existing drainage on the east side of 88th Avenue NE includes a small ditch and several driveway and 12-inch-diameter culverts. This ditch would be widened and the culvert crossings would be replaced with 18-inch-diameter culverts.

At the intersection of NE 163rd Street and 88th Avenue NE, the new diversion system would become an 18-inch-diameter HDPE pipe going down the ridge between the middle and the east ravines. An existing sanitary sewer owned by the Northshore Utility District was constructed down this ridge in 1990. The new diversion system could parallel this

existing sewer line. Diverting the 88th Avenue NE drainage down the ridge would also help solve the east ravine problem by reducing flows in the east ravine. This pipeline is discussed further under the east ravine alternatives.

The 18-inch pipe diversion would connect to the existing pipe system in NE 169th Street. This system includes 12-inch-diameter and 18-inch diameter pipe. Because the flows would be increased, a 194-foot section of 12-inch-diameter pipe would need to be replaced with 18-inch-diameter pipe. The remaining downstream system has adequate capacity to carry the diverted flows.

The Moorlands Elementary School and an area north to NE 155th Street currently flows east on NE 155th Street to the middle ravine. This alternative would include diverting the flow from this area to an existing ditch that flows north along the east side of 84th Avenue NE. This ditch includes several 12-inch-diameter culvert crossings which would need to be replaced with 18-inch-diameter culvert crossings. In addition, the existing 12-inch-diameter pipe system crossing Simonds Road NE would need to be replaced with 18-inch-diameter pipe.

The existing 84th Avenue NE drainage system north of Simonds Road NE consists of 12-inch-diameter pipe on the west side of the street and a ditch system with driveway culverts on the east side of the street. The new diversion system would be directed to the east side of the street and the existing system would be improved with an improved rock-lined ditch section and 18-inch-diameter driveway culverts. At the end of 84th Avenue NE, the diversion would be piped 800 feet north using 18-inch pipe to the existing system in NE 169th Street. Diverting the 84th Avenue NE drainage down to NE 169th Street would also solve the west ravine problem.

The hydrologic effects of the diversion were modeled using HYD and the results are illustrated on Figure 10 and Table 3. This figure illustrates the current condition 100-year flow (1990 CN's) and the 100-year flow with the two diversions in place. The results of this analysis indicate that the peak flow at the top of the middle ravine would be reduced from 19.7 cfs to 10.5 (a 47 percent reduction). The peak flow at the bottom of the middle ravine would be reduced from 30.3 cfs to 22.3 cfs (a 26 percent reduction).

Although the diversions would represent a moderate reduction in peak flows to the middle ravine, flow would be continue to be capable of transporting a large volume of sediment and debris. Consequently, this alternative would also need to include a sedimentation facility. For the cost estimate, it was assumed that this alternative would include a sedimentation facility similar to that shown on Figure 9 (Alternative M-3).

Like Alternative M-1, this alternative diverts flow away from the middle ravine, thereby improving the ravine's riparian vegetation and reducing the quantity of fine-grained materials transported to the Sammamish River. These environmental benefits are somewhat less than the benefits provided by Alternative M-1 because this alternative diverts less flow away from the middle ravine.

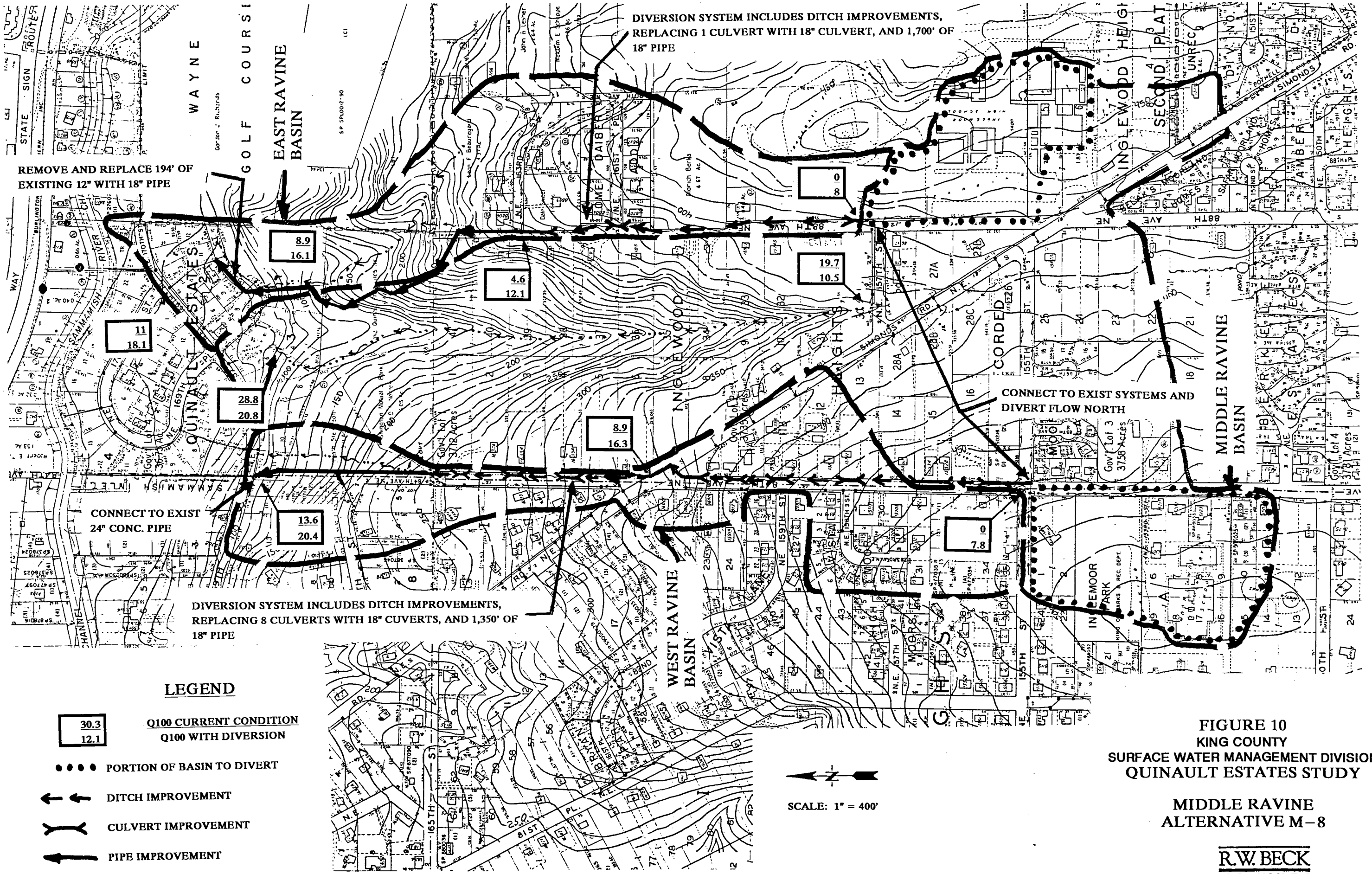

FIGURE 10
KING COUNTY
SURFACE WATER MANAGEMENT DIVISION
QUINAULT ESTATES STUDY

MIDDLE RAVINE
ALTERNATIVE M–8

R.W. BECK AND ASSOCIATES

B. WEST RAVINE ALTERNATIVES

The alternatives for the middle ravine include Alternative M-1, which includes a pipe diversion along 84th Avenue NE. Should Alternative M-1 be implemented as recommended, this alternative would also solve the west ravine problem. If Alternative M-1 is not implemented, one of the following alternative solutions will be necessary to solve the west ravine problem.

Five alternatives were evaluated for the west ravine. When considering the following alternatives, it is important to note that the preferred solution should completely solve the problem. As discussed in Section II, the County settled a lawsuit regarding the diversion of 22 acres from the south side of Simonds Road NE to the 84th Avenue NE drainage system.

1. Alternative W-1 - Tightline Upper Basin Down 84th Avenue NE

This alternative would include diverting all of the 84th Avenue NE runoff away from the ravine and down the extension of the 84th Avenue NE right-of-way in a tightline. This would eliminate nearly all of the flow in the west ravine except minor groundwater flow and minimal runoff from adjacent side slopes. The elimination of 84th Avenue NE runoff in the west ravine would solve the erosion and sedimentation problem. It would also significantly reduce the fine-grained material being transported to the Sammamish River.

The pipeline alignment would be identical to the west ravine pipeline in Alternative M-1 (Figures 7A and 7B). The new pipeline would be 18-inch-diameter CMP and would connect to the existing 24-inch-diameter system at NE 169th Street which flows north discharging to the Sammamish River. This pipe would be 6 inches smaller in diameter than the pipe proposed in Alternative M-1.

The pipeline would require installation on some slopes of up to 30 percent; however, the area appears stable. There are already two water lines located within this corridor and an 8-inch sanitary sewer is proposed for construction in 1994. Drainage easements would be required for the pipe installation.

This alternative would restore the degraded habitat of the west ravine. The significant reduction in peak flows and runoff volumes would allow the west ravine habitat to become re-established.

The reduction in stream flows also reduces the quantity of fine-grained materials that would otherwise deposit in the Sammamish River. This would improve Sammamish River fish habitat.

2. Alternative W-2 - Bed and Bank Stabilization with Rock Armoring

This alternative would include armoring the flow area of the existing channel with large rock that would be stable under high flow velocities. The stabilized channel would eliminate channel erosion, and corresponding sedimentation and flooding problems. The alternative would also include a debris barrier at the pipe inlet at the bottom of the ravine to prevent pipe plugging from woody debris.

Placement of rock and filter fabric in the existing channel would be difficult. Given the steep channel gradient and bank slopes, grading would be needed to create slopes flat enough for the riprap. Constructing access up the steep ravine (25 percent slopes) to install the rock would be difficult. The clearing and grading necessary to construct the access would also disturb the natural vegetation along the route. Because of the nature of the area, there would be some risk that a side slope failure could occur. This alternative may not be feasible and is not preferred.

3. Alternative W-3 - Expand Existing Sediment Trap

This alternative includes constructing a sediment pond as large as possible immediately upstream of the existing 24-inch-diameter pipe inlet at the bottom of the ravine. Based upon field observations, the size of the trap would be limited due to the steep slopes surrounding the pipe inlet (see Photograph 6 in Section IV). An estimated volume of 25 cubic yards would be possible, assuming a simple construction of ecology block walls to form the sides of the trap. A schematic plan of this alternative is illustrated on Figure 11.

This small amount of storage volume would help reduce the frequency of pipe plugging due to debris and sediment; however, it is too small to provide adequate protection against a significant flood event. For this reason, this alternative is not preferred.

4. Alternative W-4 - Upstream Detention

This alternative includes upstream detention along 84th Avenue NE prior to discharge to the top of the ravine. In order to ensure that upstream detention would solve the ravine erosion and related sedimentation and flooding problem, the peak flows would have to be dramatically reduced. A target release rate of the current two-year flow (3.6 cfs) was used to size the pond.

The HYD RDFAC was used to estimate the storage volume required to detain the 100-year flood to the current two-year flow. The required storage volume would be 3 ac-ft. Figure 12 illustrates a possible location of a detention pond along the west side of 84th Avenue NE. Flows would be diverted from the 84th Avenue NE system to the pond, then back to the 84th Avenue NE system, and ultimately to the existing ravine.

The alternative would also include a debris barrier at the pipe inlet at the bottom of the ravine to prevent pipe plugging by woody debris. Land acquisition of one acre would be required.

A disadvantage of this alternative is that it would continue to allow erosion. The cost of this alternative would be greater than the selected alternatives. In addition, land or easement acquisition would be required. For these reasons, Alternative W-4 is not preferred.

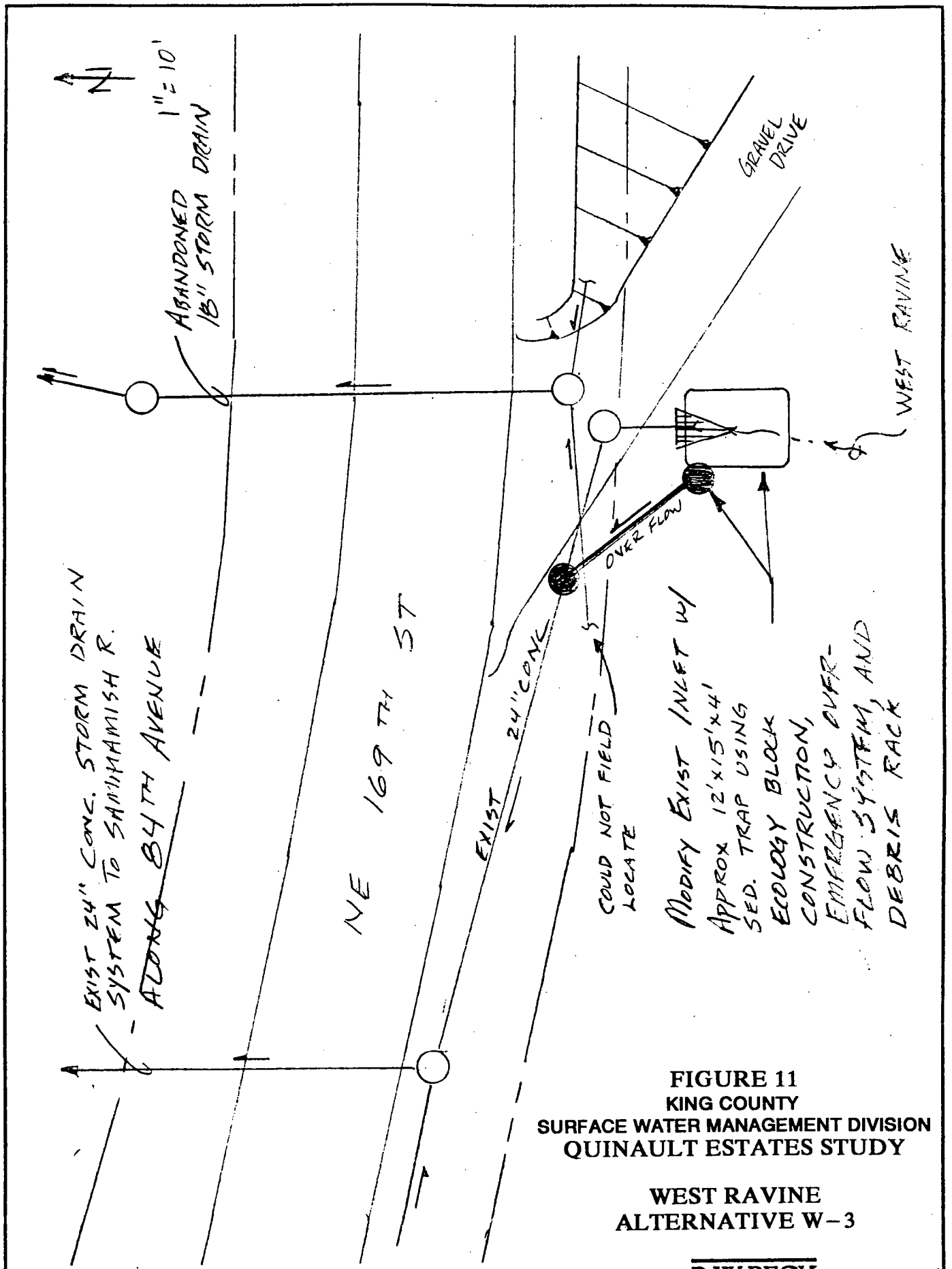

FIGURE 11
KING COUNTY
SURFACE WATER MANAGEMENT DIVISION
QUINAULT ESTATES STUDY

WEST RAVINE
ALTERNATIVE W–3

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AND ASSOCIATES

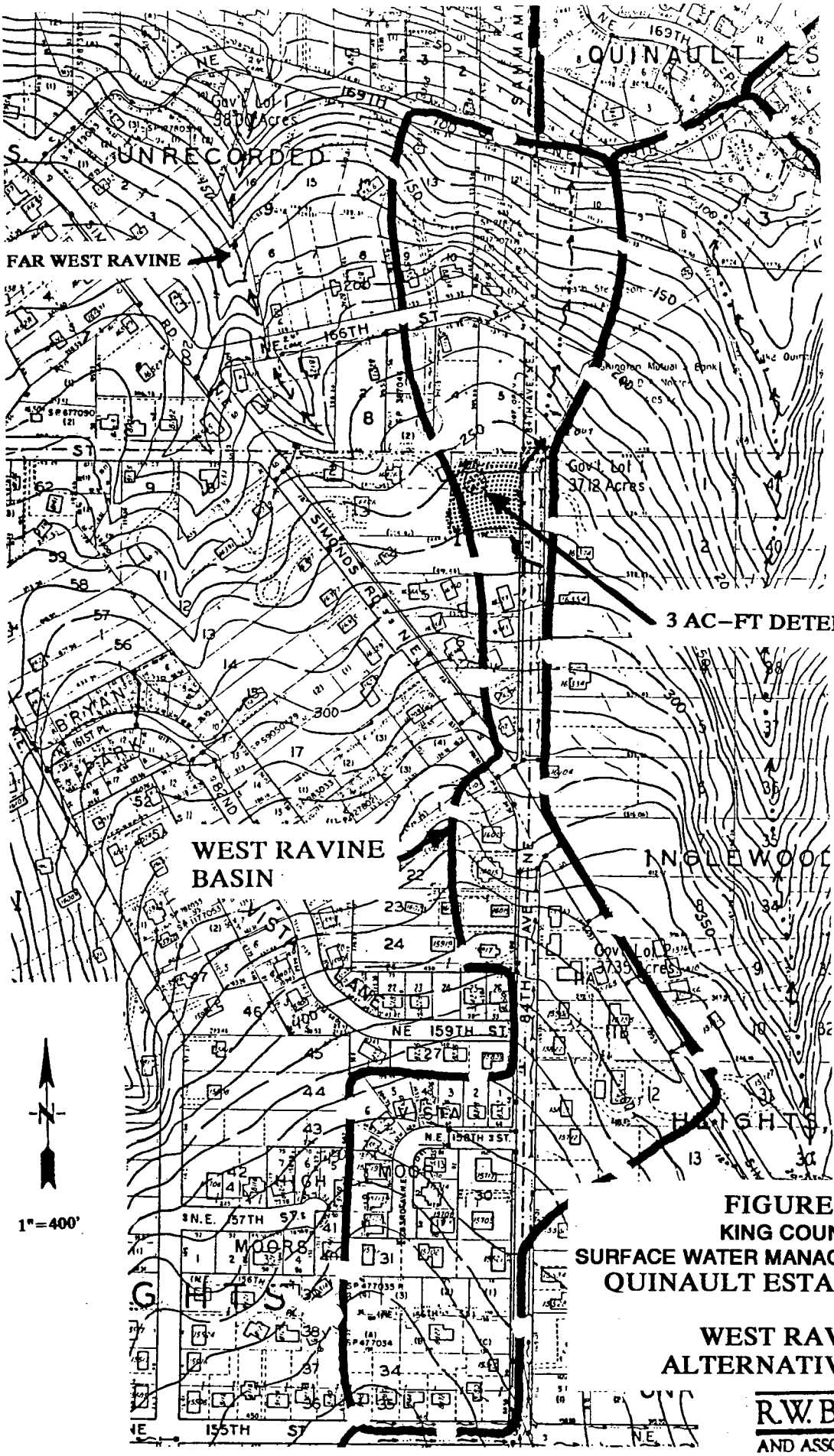

FIGURE 12
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SURFACE WATER MANAGEMENT DIVISION
QUINAULT ESTATES STUDY

WEST RAVINE
ALTERNATIVE W–4

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AND ASSOCIATES

5. Alternative W-5 - Divert 84th Avenue NE Flows to the Far West Ravine

This alternative includes diverting the 84th Avenue NE flows to another ravine, the "far west" ravine, that lies on the west side of the ravine. The far west ravine begins just south of NE 166th Street and east of Simonds Road NE (Figure 12).

This alternative was initially considered, but rejected because it has the potential for exacerbating an existing erosion and flooding problem in the far west ravine. It was first thought that the far west ravine may be able to accommodate an increase in flow. However, following the July 13 event, the County received several claims in this area relating to flood damages. Consequently, this alternative is not considered viable because it has the potential for exacerbating an existing problem. See Section VI-C for a related discussion.

C. EAST RAVINE ALTERNATIVES

Five alternatives were evaluated for the east ravine. All of the east ravine alternatives include an element which addresses the large failure downstream of the 88th Avenue Branch (see Photograph 7 in Section IV). The 88th Avenue NE drainage system going to the ravine is referred to as the "east ravine - 88th Avenue Branch". The existing steep slopes in this branch will continue to fail at a high rate and supply material that will be transported to the Quinault Estates drainage system. This failure was discussed in greater detail in Section IV. In addition, an existing sanitary sewer owned by the Northshore Utility District is located approximately 10 feet west of the top of this failure. The utility district has expressed concern that their existing sewer line could be affected should this failure continue.

1. Alternative E-1 - Divert Upper West Portion of Basin to Middle Ravine

Alternative E-1 includes a diverting the 88th Avenue Branch west down to the middle ravine. The alternative would eliminate flows to the large failure and to the lower ravine, thereby reducing erosion and transport. This alternative was only considered appropriate if it could be implemented in conjunction with the middle ravine alternative M-5 (tightlining flow through the middle ravine). Because the middle alternative M-5 was not feasible, Alternative E-1 is also not viable.

2. Alternative E-2 - Check Dams and Short Tightline of 88th Avenue Branch

This alternative includes two major components and is illustrated on Figure 13. The first component includes diverting the 88th Avenue Branch around the large failure and discharging to the east ravine stream just below the confluence of the 88th Avenue Branch and the natural channel. This would eliminate runoff to the large failure and would significantly reduce the rate of slope failures. Even with the diversion, spalling and smaller failures may continue at a less frequent rate due to natural weathering and freeze-thaw processes.

The volume of sediment transported by the system would be reduced from current conditions because the short tightline would essentially eliminate the supply of material coming from the 88th Avenue Branch failure. However, the short diversion would not reduce the flow rates in the lower and middle stream reaches, nor would it affect the current

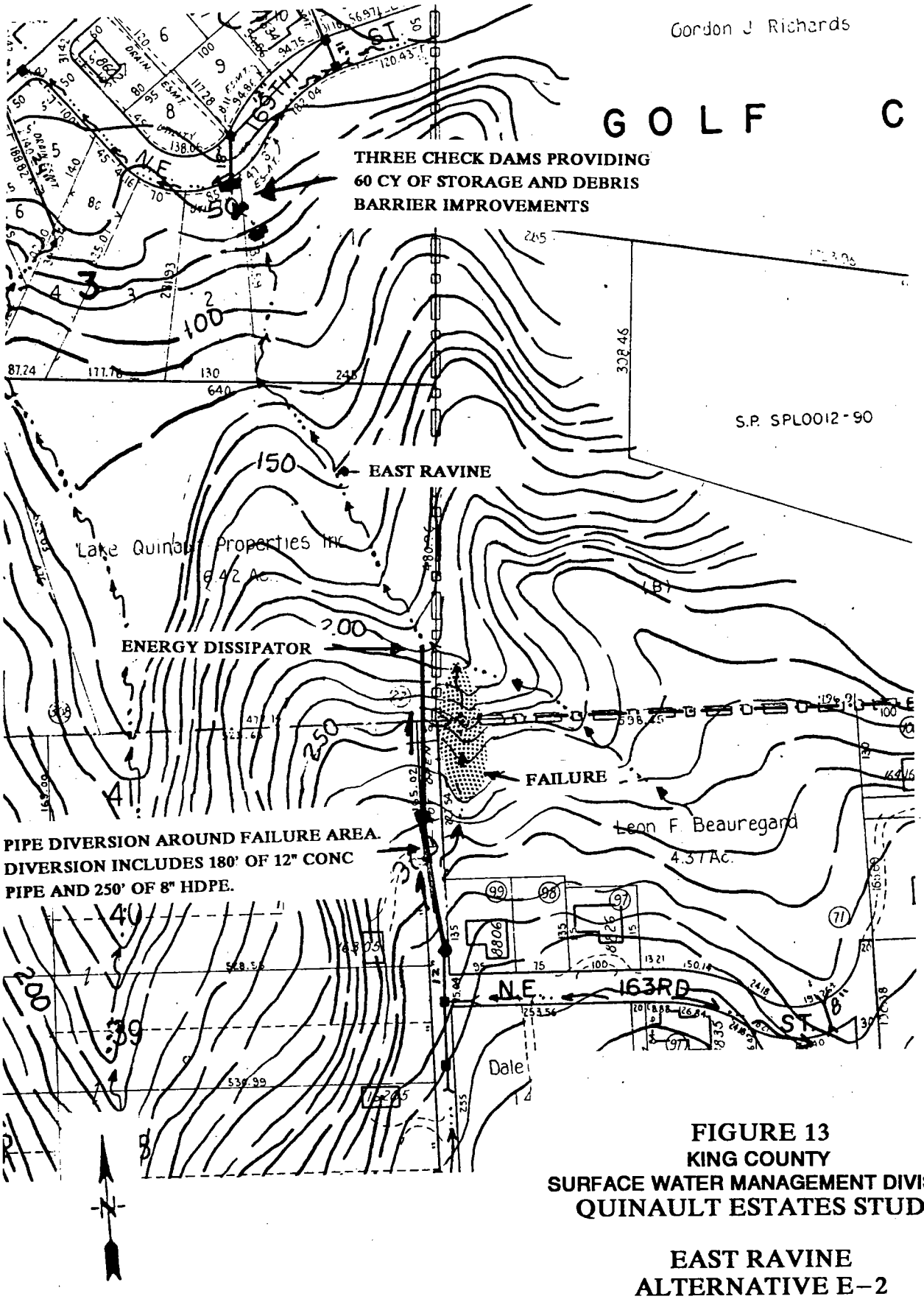

FIGURE 13
KING COUNTY
SURFACE WATER MANAGEMENT DIVISION
QUINAULT ESTATES STUDY

EAST RAVINE
ALTERNATIVE E–2

SCALE: 1"=100'

R.W. BECK
AND ASSOCIATES

erosion occurring on the east branch (upstream of station 8+00 of the natural channel.) Therefore, some erosion and sediment transport would continue.

The second component of the alternative includes 3 small check dams in the lower 100-foot reach immediately upstream of the pipe inlet on 169th Street NE. Installing check dams along the lower 100-foot section was considered viable because this reach of stream lies adjacent to an existing access road on its west bank. The existing access road could be used for both construction of the check dams and long-term removal of sediment.

A very preliminary layout of this alternative is included in Appendix C. Using a set of three gabion check dams of 5 feet in height, the total sediment storage provide by the check dams would be about 60 cubic yards. This would triple the volume provide by the existing sediment trap. However, the volume provided by this alternative would be about half of the sediment storage volume incorporated into the County's 1988 design of the sediment pond at this location. The alternative would also include debris barrier/pipe inlet improvements.

The estimated cost of the check dams would be on the same order of magnitude as a sediment pond in this location (Alternative E-3, discussed below). Because it would provide less sediment storage volume for about the same cost, this alternative was not preferred.

3. Alternative E-3 - Sediment Pond and Partial Tightline of 88th Avenue NE Drainage

This alternative is similar to Alternative E-2. It has two major components, and one of the components is the short diversion of the 88th Avenue Branch. The second component differs from Alternative E-2 in that instead of check dams at the lower end of the ravine, there would be a large sediment pond.

The sediment pond would provide approximately 125 cubic yards of sediment storage and would be very similar to the County's design developed in 1988. As discussed in Section II, the County developed a design of a sediment pond at the lower end of the ravine at the pipe system inlet. The County was unable to obtain the land rights for Lot 2, Division 3 of Quinault Estates, and the project was abandoned.

It may be possible to obtain the land rights at this time because the owner of this lot recently gave the Northshore Utility District a permanent sewer line easement in this same vicinity. With that easement in place, it may be less likely that the property owner would refuse an easement for a pond. Apparently, the owner rejected the earlier request for an easement because it would have restricted access to his large, undeveloped parcel. However, an access road was built for the sewer line, and the proposed pond would not alter the existing road and driveway. The utility district and the property owner would likely require that permanent driveway access to the property and the sewer line be a condition of constructing the pond.

The alternative is illustrated on Figure 14. A preliminary sketch of the sediment pond at a scale of 1"=10' is included in Appendix C.

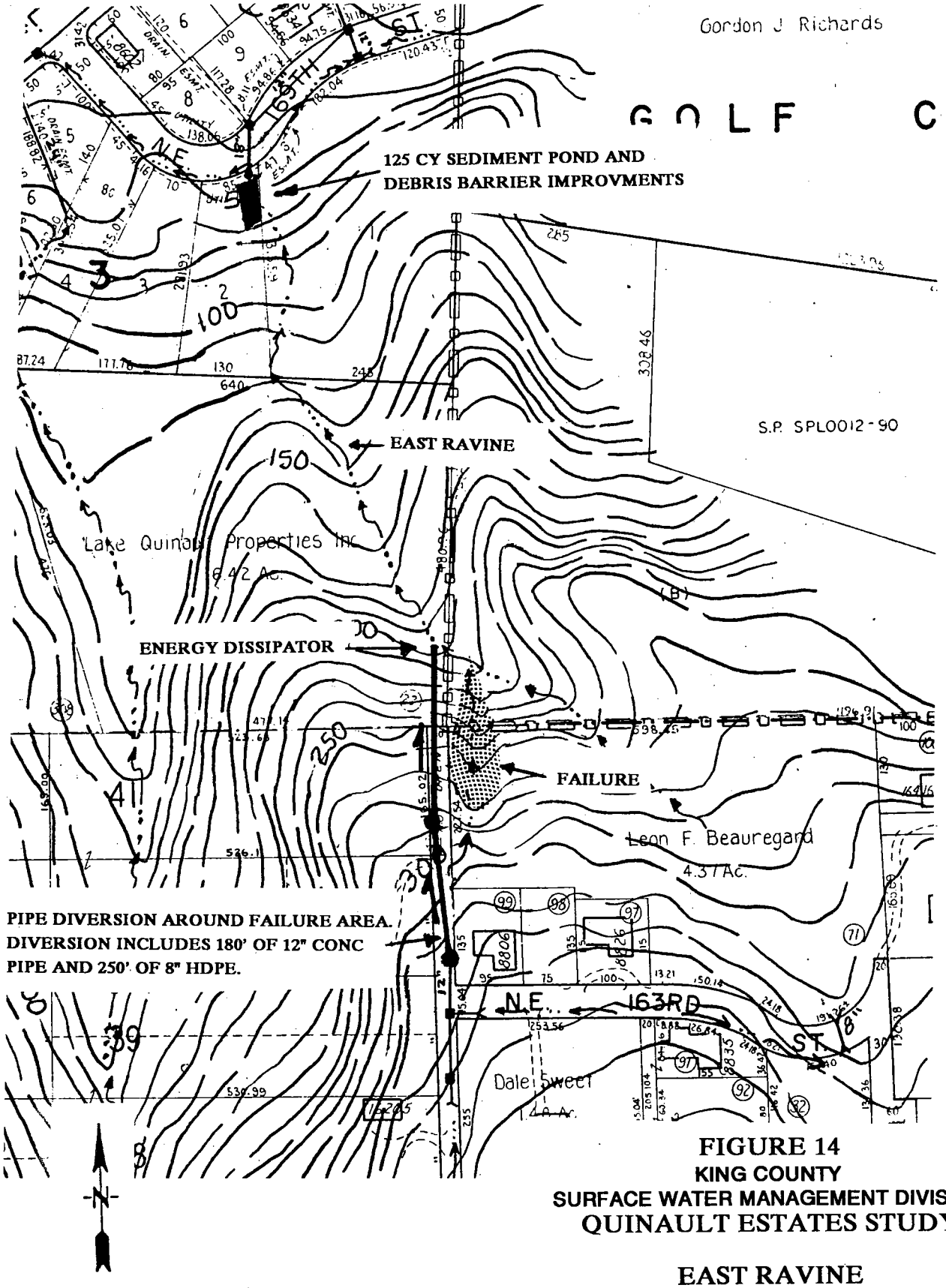

FIGURE 14
KING COUNTY
SURFACE WATER MANAGEMENT DIVISION
QUINAULT ESTATES STUDY

EAST RAVINE
ALTERNATIVE E-3

SCALE: 1"=100'

R.W. BECK
AND ASSOCIATES

As with Alternative E-2, the volume of sediment transported by the system would be reduced from current conditions because the short tightline would eliminate the supply of material coming from the 88th Avenue Branch. However, the short diversion would not reduce the flow rates in the middle and lower stream reaches, nor would it affect the current erosion occurring on the east branch. Therefore, some erosion and sediment transport would continue.

The sediment pond would provide approximately 125 cubic yards of sediment storage. This storage volume is approximately 6 times that of the current sediment trap. This additional volume would be effective in trapping sand and gravel, but would allow the fine-grained material to pass through the pipe system to the Sammamish River.

A sediment storage of 125 cubic yards is adequate, compared to the probable sediment volumes that would be delivered. As discussed previously, the east ravine sediment balance has been dramatically affected by the volume of material made available by the large failure on the 88th Avenue Branch. Once the process of repeated failures is stopped, the ravine will return to a dynamic balance with much lower volumes of sediment input and output. However, there is a residual sediment volume of 500 to 1,500 cubic yards of material from these failures which now rests in the lower and middle reaches of the ravine. This material lies in the channel bottom, flood plain and banks and has become partially vegetated. Based on recent observations, the proposed 125 cubic yards should be adequate to catch a significant volume of the material, although a large event may still transport a sediment volume that would plug or overtop the proposed system. This probability would decrease over time as the accumulated material is removed.

The increase in sediment storage volume would significantly increase the level of protection afforded by the existing system. One disadvantage of a sediment pond is that there might be more environmental permitting issues than other alternatives, particularly the tightline. It also would require regular maintenance costs. This alternative is one of the preferred alternatives for the east ravine and is evaluated in more detail in Section VI.

4. Alternative E-4 - Upstream Detention of 88th Avenue Branch

This alternative includes a detention pond at the north termination of 88th Avenue NE, immediately upstream of the large failure of the 88th Avenue NE branch. This alternative was rejected because of the following:

- A detention pond would reduce the peak rates of flow from the 88th Avenue NE drainage ditch to the 88th Avenue Branch and the downstream failure; however, the failure in the 88th Avenue Branch is so steep that any surface discharge to it, even at reduced rates, would contribute to more slope failures.

- The steep topography of the areas available for a detention pond site would make the construction of a pond costly.

- The stability of the hillslopes in the area is poor. The construction and long-term operation of a detention pond could negatively affect slope stability.

- Detaining the 88th Avenue NE drainage would not lower flows in the east branch. Therefore, the overall reduction in flows of the middle and lower reaches of the ravine would not be significant.

5. Alternative E-5 - Tightlining 88th Avenue Branch Along Existing Sewer Line

This alternative includes a tightline diversion of the 88th Avenue Branch down a ridge between the east and middle ravines along the existing sanitary sewer owned by the Northshore Utility District. This alternative is illustrated on Figure 15. The 8-inch-diameter sanitary sewer was installed in 1990 and extends from the termination of 88th Avenue NE down to NE 169th Street.

The hydrologic affects of the diversion were evaluated using the HYD model for the 100-year event. The peak diverted flow from the 88th Avenue NE drainage system would be 4.6 cfs. This would eliminate nearly all of the discharge to the large failure.

The peak flow at the confluence of the east branch and the 88th Avenue Branch would decrease from 8.1 cfs to 3.6 cfs (56 percent reduction). The peak flow at the bottom of the ravine would decrease from 8.1 cfs to 3.6 cfs (56 percent reduction).

The volume of sediment transported by the system would be less than any of the other alternatives for two reasons:

- The tightline would eliminate the supply of material coming from the 88th Avenue Branch

- The reduction in stream flow between the confluence of the two branches and the lower end of the ravine would reduce both the erosion and the ability of the stream to transport the sediment

Because there would continue to be flow in the system, the alternative would include debris barrier improvement at the pipe inlet at the bottom of the stream.

The diversion pipe would be installed at slopes ranging from 7.5 percent to 40 percent. The diversion pipe would include 1,200 feet of 8-inch-diameter HDPE pipe plus 110 feet of 12-inch-diameter concrete pipe. The pipe would be installed along the alignment of the existing sewer pipeline. The Lakeshore Utility District was contacted regarding the stormwater diversion. Mr. Boris Shakhnovich, District Engineer, indicated that the district would support the stormwater diversion as long as it does not impact their existing sewer line. The district is concerned about their pipeline being located very close to the large failure. The diversion would reduce the potential for continue slope failures.

The sewer is located within a 10-foot permanent easement. Some new easements for the tightline would probably be required. Along this pipeline route, there is one section that may be difficult construction. This section is along the top of a 14-foot wide ridge, which is 30 feet high and has approximately 1:1 side slopes. Design of this section should incorporate input from a geotechnical engineer. Photographs of the proposed pipeline route are included in Volume III.

The tightline would connect into the existing 18-inch-diameter pipe system on the south side of NE 169th Street. As discussed in Section IV, Hydrologic/Hydraulic Findings, the downstream section of pipe from the 18-inch-diameter pipe has slightly less capacity than the simulated 100-year flow. This pipe section includes 194 feet of 12-inch-diameter concrete pipe and has a capacity of 8 cfs. The 100-year peak flow is estimated to be 8.9 cfs. The capacity of this pipe reach could be increased simply by raising the elevation of the catch basin lid and allowing some surcharging of flow. It currently lies several feet below the road elevation.

D. ALTERNATIVE EVALUATION

The alternatives, including the no-action alternative, were evaluated in terms of several criteria, listed below.

Evaluation Criteria

- Feasibility and constructibility
- Compatibility with the downstream drainage system
- Costs
- Environmental considerations
- Advantages and disadvantages

A summary of alternative ratings for these criteria is shown on Tables 4A, 4B, and 4C for the middle, west, and east ravines, respectively. Cost estimates were developed using the County's standard cost estimating spreadsheet. The costs include 20 percent contingency, 8.2 percent sales tax and cost allowances for design and construction management/inspection. Tables 4A, 4B, and 4C were used to evaluate and compare the alternatives, and select the recommended alternative. The selection of the preferred alternative is discussed in the following section.

SCALE: 1"=100'±
CONTOUR INTERVALS 50'

CITY OF BOTHELL

EAST BRANCH

LARGE FAILURE

88TH AVE NE BRANCH

NE 163 RD STREET

88TH AVENUE NE

RAISE EXISTING CB RIM AND PROVIDE LOCKING LID TO INCREASE CAPACITY OF DOWNSTREAM 12" PIPE

CONNECT NEW 8" HDPE TO EXISTING MANHOLE

INLET DEBRIS BARRIER IMPROVEMENTS

MH #1

MH #2

MH #3

MH #4

MH #5

MH #6

MH #7 BEGIN 8" HDPE PIPE

MH #8 CONNECT TO EXISTING 12" SYSTEM WITH 220 LF NEW 12" CONCRETE PIPE

ALIGN 1,200 LF OF NEW 8" HDPE PIPE ADJACENT TO EXISTING SEWER LINE. (5' TO 10' SEPARATION). MANHOLES REQUIRED WHERE CHANGES IN HORIZONTAL OR VERTICAL ALIGNMENT PRECLUDE DEFLECTING PIPE. ADDITIONAL EASEMENT FOR STORM DRAIN REQUIRED. SLOPE OF NEW PIPE WILL BE SIMILAR TO SEWER PIPE.

EXISTING 8" HDPE SEWER (PIPE SLOPE INDICATED IN PARENTHESES)

EAST RAVINE

MIDDLE RAVINE

NE 169 TH ST

NOTE:
1. DISTANCE, PROPERTY LINES, LOCATIONS AND CONTOURS ON THIS MAP ARE APPROXIMATE.

G.D. K:\KA420\KA420004 12-02-93 ● 13:34

FIGURE 15
KING COUNTY
SURFACE WATER MANAGEMENT DIVISION
QUINAULT ESTATES
EAST RAVINE
ALTERNATIVE E-5

R.W. BECK AND ASSOCIATES

Table 4A

ALTERNATIVE EVALUATION SUMMARY
MIDDLE RAVINE

Alt. No.	Brief Description	Feasibility and Constructibility	Compatibility With Downstream Drainage System	Cost Construction (4)	Cost Total (2)	Environmental Considerations	Advantages	Disadvantages	Comments
	No Action	Not applicable	Current flooding and sediment deposition problems would continue Sediment deposition in Sammamish River would continue	Continued costs associated w/ claims, law-suits, & prop-erty damage	Continued costs associated w/ claims, law-suits, & prop-erty damage	Ravine is identified as landslide and erosion hazard area Dept. of Fisheries has urged County to reduce sediment load to Sam-mamish River		Continued flooding of Quinault Estates residences and roads Continued sediment load to Sam-mamish River	Not acceptable
M-1	Divert upper basin around ravine, to Simond Rd and 84th Street to existing pipe system dis-charging to Sammamish River.	Generally simple pipeline cons-truction, except requires 700' of 12' deep trench and 400 ft ft of installation on 25% slopes. Requires easement acquisition along 84th Ave and at Day residence	Solves flooding and sediment deposi-tion problem to Quinault Estates. Significantly reduces sediment load to Sammamish River Existing 84th Ave system has capacity to accept diverted flow.	$468,000 (3)	$825,000 (3)	Significantly reduces sediment load to Sammamish River Improves ravine habitat, allowing it to become better established by reducing major flood flows	Reliable solution. Solves problem at source rather than treating a symptom of problem Generally, simple pipeline construction compared to other feasible alternatives Solves west ravine erosion problem Probably supported by residents		
M-2	Bank Stabilization/Gradient reduction by placing fill in ravine bottom and raising channel	Risky construction access due to unstable slopes Many easements required	Solves flooding and sediment deposi-tion problem to Quinault Estates. Once new vegetation is completely establish, sediment load to Sam-mamish River would be significantly reduced	$666,000	$1,160,000	Wide corridor along ravine bottom would be completely cleared and replanted and would include a rock lined channel at the bottom of the ravine. There would be signif--nificant impacts to natural habitat Ultimately reduces sediment load to Sammamish River once new plantings are established	Solves problem at source rather than treating a symptom of problem	Highest cost alternative Greatest impact to ravine May not work: Hillslope movement may continue	
M-3	500 CY Sediment pond at bottom of ravine	Simple Construction Easement required from four properties	Would reduce sediment entering drainage system and Sammamish River Would decrease the frequency of and sediment deposition problems	$126,000	$305,000	Significantly reduces sand and gravel load to the Sammamish River. Some reduction in silts and clays.	Lowest Cost Solution	– Would decrease the frequency of flooding and sediment deposition problems; however, pond would not provide complete protection for major storms such as the July 13 event – Land rights required and probable resistance from residents – Continued Maintenance Cost – Required access route across Day lot	Second best alternative
M-4	Upstream 7.5 ac-ft detention pond at NE 157th Street	Land acquisition required from four properties Simple construction	Would reduce downstream peak flow rates, but not runoff volumes Erosion and Sediment load would continue	$208,000	$470,000	Less reduction in erosion/sediment-ation than other alternatives	Simple construction	Probably would not solve problem	Not a feasible alternative because it would probably not solve problem
M-5	Tightline flow in ravine	Very difficult to construct pipe-line down ravine. Long-term maintenance issues There are technical issues re-garding the handling of ravine side inflows (i.e, whether to collect or ignore these flows)	Solve flooding and sediment deposi-tion problem to Quinault Estates. Reduces sediment load to Sammamish River	$537,000	$1,005,000	Reduces sediment load to Sammamish River Construction of pipeline would disturb ravine habitat		Extreme construction difficulties Pipeline in ravine could be long term maintenance problem For a surface installation, there may be vandalism	Because of construction difficulties this alternative is not considered feasible
M-6	Pipe inlet improvements to pass debris and second vault at discharge to Sammamish River	Easement required for two properties at pipe inlet	Without significant sediment storage prior to entering the pipe system, this would not solve flooding or sedimentation problem	No estimate	No estimate	Does not solve problem, so current conditions would continue		Without significant sediment storage prior to entering the pipe system, this alternative would not solve flooding or sedimentation problem	Does not solve problem
M-7	Smaller sediment pond and con-crete open channel to Sam-mamish River	Channel would fill with sediment in lower portion of system Land acquisition required	Would include construction of a con-crete open channel system to Sam-mamish River.	No estimate	No estimate	Would deliver additional sediment to Sammamish River Not permittable		Channel would become filled with with sediment during major events and not function properly Fast, unsafe velocities in channel	Not a feasible alternative
M-8	Divert runoff from Inglemoor HS to east ravine and from Moor-land Elementary to west ravine to reduce flows in middle ravine	Would solve east and west ravine problems Simple construction	Peak flows would be reduced by 1/3. This would reduce problem and increase level of protection, but not completely solve the problem.	$551,000	$1,065,000	Moderate reduction in sediment load to Sammamish River	Solves west and east ravine problems	Peak flows would be reduce by 1/3. This would reduce problem and increase level of protection, but not completely solve the problem.	Includes sediment pond in middle ravine, therefore, also refer to Alt. M-3 above

Notes
(1) Heavy outline indicates recommended alternative
(2) Includes costs for tax, design, construction management and inspection, 20% construction contingency, and land/easement acquisition
(3) This alternative solves west ravine problem, which is estimated at $250,000. Therefore, the net cost for solving the Middle ravine alone is $575,000
(4) Includes costs for construction and sales tax only.

Quinault Estates

Table 4B

ALTERNATIVE EVALUATION SUMMARY
WEST RAVINE

Alt. No.	Brief Description	Feasibility and Constructibility	Compatibility With Downstream Drainage System	Cost		Environmental Considerations	Advantages	Disadvantages	Comments
				Construction (3)	Total (2)				
	No Action	Not applicable	Current flooding and sediment deposition problems would continue Sediment deposition in Sammamish River would continue	Continued costs associated w/ claims, law-suits, & prop-erty damage	Continued costs associated w/ claims, law-suits, & prop-erty damage	Ravine is identified as landslide and erosion hazard area Dept. of Fisheries has urged County to reduce sediment load to Sam-mamish River		Continued flooding of Quinault Estates residences and roads Continued sediment load to Sam-mamish River Continued erosion of existing channel	Not acceptable
W-1	Divert upper basin around ravine, along 84th Ave NE to existing pipe system dis-charging to Sammamish River.	Generally simple pipeline cons-truction, except on 25% slope Requires easement acquisition along 84th Ave NE	Solves flooding and sediment deposi-tion problem to Quinault Estates. Reduces sediment load to Sammamish River	$112,000	$250,000	Reduces sediment load to Sam-mamish River Improves ravine habitat, allowing it to become better established by reducing major flood flows and corresponding erosion	Solves problem at source rather than treating a symptom of problem Generally, simple pipeline construction compared to other feasible alternatives Very reliable solution		If the middle ravine alternative solution M-1 is selected, it would include this alternative
W-2	Bed and bank stabilization with rock armoring	Difficult access due to steep and unstable slopes Easements required	Reduces flooding and sediment dep-osition problem to Quinault Estates.	$112,000	$250,000	Reduces sediment load to Sammamish River	Solves problem at source rather than treating a symptom of problem	Some erosion would continue to occur. Greatest impact to ravine. May not work: Hillslope movement could continue, which would supply material	
W-3	Expand Sediment Pond to 25 CY volume	Simple Construction Easement required	Little affect on reducing fines trans-ported to the Sammamish River Would decrease the frequency of flooding and sediment deposition problems	$27,000	$33,000	Reduced sand and gravel load to Sammamish River	Lowest Cost Solution	Would decrease the frequency of flooding and sediment deposition problems, however, pond is too small to provide protection against major storms Continued Maintenance Cost	Would not completely solve problem
W-4	Upstream detention	Land acquisition required Simple construction	Would reduce downstream peak flow rates, but not runoff volumes Erosion and sediment load would be reduced	$203,000	$435,000	Less reduction in erosion/sediment-ation than alternative W-1	Simple construction	Land acquisition. Some erosion would continue. Highest Cost Alternative	
W-5	Divert flow to far west ravine	Simple construction	Would solve west ravine flooding and sediment problems, however would exacerbate the existing far west ravine erosion and sediment depostion problems	No estimate	No estimate	Would improve west ravine habitat but worsen far west ravine habitat		Would exacerbate an existing problem in far west ravine Would create liability for County	Not viable because it would excacerbate an existing problem in far west ravine

Notes
(1) Heavy outline indicates recommended alternative
(2) Includes costs for tax, design, and construction management, 20% construction contingency, and land/easement costs
(3) Includes construction costs and sales tax only.

Quinault Estates

Table 4C

ALTERNATIVE EVALUATION SUMMARY
EAST RAVINE

Alt. No.	Brief Description	Feasibility and Constructibility	Compatibility With Downstream Drainage System	Cost		Environmental Considerations	Advantages	Disadvantages	Comments
				Construction (3)	Total (2)				
	No Action	Not applicable	Current flooding and sediment deposition problems would continue Sediment deposition in Sammamish River would continue	Continued costs associated w/ claims, & prop-erty damage	Continued costs associated w/ claims, & prop-erty damage	Ravine is identified as landslide and erosion hazard area Dept. of Fisheries has urged County to reduce sediment load to Sam-mamish River		Continued flooding of Quinault Estates residences and roads Continued sediment load to Sam-mamish River Continued erosion of existing channel	Not acceptable
E-1	Divert upper west portion of basin to middle ravine	Construction on steep slopes, up to 50% Requires easement	Only appropriate if implemented with the middle ravine tightline alternative (M-5) Reduces flooding and sediment load to Sammamish River	$98,000	$214,000	Reduces sediment load to Sam-mamish River from east ravine Improves ravine habitat, allowing it to become better established by reducing major flood flows	Reduces erosion and sedimentation problem in east ravine		Must be implemented with an alt-ernative that prevents further erosion in middle ravine (Alternative M-5). Otherwise, it would worsen middle ravine problem
E-2	Bank stabilization with check dams and tightline of 88th Ave drainage around failure area	Difficult access due to steep and unstable slopes Easements required	Reduces flooding and sediment load to Sammamish River Some reduction in fine-grained mat-erial transported to Sammamish River	No estimate	No estimate	Constructing access impacts natural ravine Reduced sand and gravel load to Sammamish River Maintenance of check dams would disturb stream	Flows bypass the failure area reducing erosion in this area	May not solve problem due to insuf-ficeint sediment storage volume Without reduction in flows, sediment transport of fine-grained material will continue Difficult construction Less reliability that Alt.s E-3 and E-5	
E-3	Sediment pond and tightline of 88th Ave drainage around failure area	Difficult access due to steep and unstable slopes Easements required	Reduces flooding and sand and gravel load to Sammamish River Some reduction in fine-grained mat-erial transported to Sammamish River	$96,000	$226,000	Reduced sand and gravel load to Sammamish River Sediment ponds require extra environmental permitting work	Lowest Cost Solution Flows bypass the failure area reducing erosion in this area	Would decrease the frequency of flooding and sediment deposition problems. The level of protection is difficult to predict, however, the it would have functioned properly during the July 13 event. Continued Maintenance Cost	Second best alternative
E-4	Upstream detention	Land acquisition required Simple construction	Would reduce downstream peak flow rates, but not runoff volumes Erosion and sediment load would be reduced	$82,000	$186,000	Less reduction in erosion/sediment-ation than other alternatives Only small reduction in peak flows because the east branch of the upper basin is not detained.	Simple construction	Land acquisition. Erosion would continue. Does not solve problem	
E-5	Tightline 88th Ave flow along existing sewer	Difficult construction on steep slopes, but easier than Alt. E-3 Easements required	Reduces flooding and sand and gravel load to Sammamish River Greatest reduction in fine-grained material transported to Sammamish River	$125,000	$270,000	Improves ravine habitat by reducing large flood flows	May be easier to permit and aquire easements than other alternatives Reduces problem at the source Most reliable solution	Highest cost solution	

Notes
(1) Heavy outline indicates recommended alternative
(2) Includes costs for tax, design, construction management and inspection, 20%construction contingency, and land/easement acquisition costs.
(3) Includes costs for construction and sales tax only.

TABLE 5

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–1
PAGE 1 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY UNITS	UNIT COST $/UNIT	COST
1	Mobilization	1 sum	0.07 % of sum	$28,299.60
2	Clearing and grubbing (Light cover)	acres	$2,800 /acres	$0.00
3	Clearing and grubbing (Heavy cover)	1.0 acres	$3,650 /acres	$3,650.00
4	Excavation (Including haul off–site)	200.0 yd3	$8.25 /yd3	$1,650.00
5	Embankment Compaction	yd3	$2 /yd3	$0.00
6	Structural Fill (Including compaction)	yd3	$15 /yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)	l.f.	$17 /l.f.	$0.00
8	Gravel, Class B	ton	$20 /ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)	450.00 ton	$20 /ton	$9,000.00
10	Streambed Gravel (1.7 tons/yd3)	ton	$27 /ton	$0.00
11	Rip Rap (1.6 tons/yd3)	ton	$27 /ton	$0.00
12	Hydroseeding	1.0 acres	$1,400 /acre	$1,400.00
13	Gabions (with road access)	yd3	$175 /yd3	$0.00
14	Gabions (without road access)	yd3	$275 /yd3	$0.00
15	Asphalt Patching (incl. crushed rock)	200.0 yd2	$22 /yd2	$4,400.00
16	Extruded Asphalt Curb	l.f.	$6 /l.f.	$0.00
17	Topsoil	20.0 yd3	$27 /yd3	$540.00
18	Concrete Class A (Includes forms and rebar)	yd3	$1,600 /yd3	$0.00
19	* 12" Dia. R.C.P.	l.f.	$40 /l.f.	$0.00
20	* 18" Dia. R.C.P.	l.f.	$45 /l.f.	$0.00
21	* 24" Dia. R.C.P.	200.0 l.f.	$55 /l.f.	$11,000.00
22	* 30" Dia. R.C.P.	780.0 l.f.	$84 /l.f.	$65,520.00
23	* 36" Dia. R.C.P.	l.f.	$97 /l.f.	$0.00
24	* 42" Dia. R.C.P	l.f.	$127 /l.f.	$0.00
25	* 48" Dia. R.C.P.	l.f.	$150 /l.f.	$0.00
26	* 54" Dia. R.C.P.	l.f.	$175 /l.f.	$0.00
27	* 60" Dia. R.C.P.	l.f.	$215 /l.f.	$0.00
28	* 72" Dia. R.C.P.	l.f.	$300 /l.f.	$0.00
29	* 84" Dia. R.C.P.	l.f.	$350 /l.f.	$0.00
30	* 96" Dia. R.C.P.	l.f.	$475 /l.f.	$0.00
31	*108" Dia. R.C.P.	l.f.	$615 /l.f.	$0.00
32	* 12" Dia. H.C.M.P.	70.0 l.f.	$36 /l.f.	$2,520.00
33	* 18" Dia. H.C.M.P.	l.f.	$40 /l.f.	$0.00
34	* 24" Dia. H.C.M.P.	2215.0 l.f.	$50 /l.f.	$110,750.00
35	* 30" Dia. H.C.M.P.	l.f.	$64 /l.f.	$0.00
36	* 36" Dia. H.C.M.P.	l.f.	$72 /l.f.	$0.00
37	* 42" Dia. H.C.M.P.	l.f.	$90 /l.f.	$0.00
38	* 48" Dia. H.C.M.P.	l.f.	$100 /l.f.	$0.00
39	* 54" Dia. H.C.M.P.	l.f.	$105 /l.f.	$0.00
40	* 60" Dia. H.C.M.P.	l.f.	$110 /l.f.	$0.00
41	* 72" Dia. H.C.M.P.	l.f.	$140 /l.f.	$0.00
42	* 84" Dia. H.C.M.P.	l.f.	$161 /l.f.	$0.00
43	* 96" Dia. H.C.M.P.	l.f.	$195 /l.f.	$0.00
44	*108" Dia. H.C.M.P.	l.f.	$250 /l.f.	$0.00
45	* 12" Dia. H.D.P.P.	l.f.	$56 /l.f.	$0.00
46	* 18" Dia. H.D.P.P.	l.f.	$67 /l.f.	$0.00
47	* 24" Dia. H.D.P.P.	l.f.	$90 /l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)	each	$1,200 /each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)	15 each	$3,400 /each	$51,000.00
50	48" Type II S.D.M.H. (>12 ft.)	2 each	$4,500 /each	$9,000.00
51	54" Type II S.D.M.H. (<12 ft.)	each	$4,000 /each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)	each	$5,000 /each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)	each	$5,500 /each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)	each	$9,000 /each	$0.00
55	Flow Controller (FROP–T) Device	each	$840 /each	$0.00
56	96" Flow Controller Manhole (<12 ft.)	each	$23,000 /each	$0.00
57	96" Flow Controller Manhole (>12 ft.)	each	$34,000 /each	$0.00
58	Trash Rack	each	$500 /each	$0.00
59	New Debris Barrier and Stream Entrance	1 each	$10,000 /each	$10,000.00
60	Remove and Replace Rockery	350 c.y	$150 /c.y	$52,500.00
61	Erosion Control Measures (Filter fence, etc...)	1 lump	$8,000 /lump	$8,000.00
62	Traffic Control	100.0 hour	$20 /hour	$2,000.00
63	Extra Depth Trench	700.0 l.f.	$20 /l.f.	$14,000.00
64	Landscaping & Restoration	1 lump	$40,000 /lump	$40,000.00
65	Remove and Replace Existing Cement Concrete Sidewalk	25 s.y	$30 /s.y.	$750.00
66	Rough Grading down slope	1 lump	$5,000 /lump	$5,000.00
67	Pipe Anchors at 1 per 50 ft	16 each	$100 /each	$1,600.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$432,579.60
	SALES TAX 8.2%:	0.082	$35,471.53
	SUBTOTAL:		$468,051.13
	CONTINGENCY:	0.20	$93,610.23
TOTAL	CONSTRUCTION		$561,661.35

TABLE 5 (CONTINUED)

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–1
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	14.00 days	$1,300 /day	$18,200.00
2	GEOTECHNICAL ENGINEERING	8.00 days	$600 /day	$4,800.00
3	ENGINEERING DESIGN	100.00 days	$400 /day	$40,000.00
4	PROJECT MANAGEMENT	100.00 days	$500 /day	$50,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$21,640
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$21,640
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$102,259.45
10	RIGHT–OF–WAY PERSONNEL (per parcel)	L. Sum	$1,500	$0.00
11	RIGHT–OF–WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	0.4 acres	$12,000 /acres	$4,800.00
	GRAND TOTAL	TOTAL PROJECT COST:		$825,000.80

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 6

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–2 Bank Stabilization
PAGE 1 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$40,290.95
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	6.0	acres	$3,650	/acres	$21,900.00
4	Excavation (Including haul off–site)	500.0	yd3	$8.25	/yd3	$4,125.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)		l.f.	$17	/l.f.	$0.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)	450.00	ton	$20	/ton	$9,000.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)	2600.0	ton	$27	/ton	$70,200.00
12	Hydroseeding	4.4	acres	$1,400	/acre	$6,160.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)		each	$3,400	/each	$0.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP–T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	New Debris Barrier and Stream Entrance		each	$8,000	/each	$0.00
60	Remove and Replace Rockery		c.y	$150	/c.y	$0.00
61	Erosion Control Measures (Filter fence, etc...)	5.0	acres	$10,000	/acres	$50,000.00
62	Traffic Control	40.0	hour	$20	/hour	$800.00
63	Intake Structure	1	each	$8,000	/each	$8,000.00
64	Landscaping	6.0	acres	$10,000	/acres	$60,000.00
65	Ravine Fill	50000	c.y.	$6	/s.y.	$300,000.00
66	Rough Grading down slope	1	lump	$40,000	/lump	$40,000.00
67	Pipe Anchors at 1 per 50 ft	54	each	$100	/each	$5,400.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$615,875.95
	SALES TAX 8.2%:	0.082	$50,501.83
	SUBTOTAL:		$666,377.78
	CONTINGENCY:	0.20	$133,275.56
TOTAL	CONSTRUCTION		$799,653.33

TABLE 6 (CONTINUED)

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–2
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	24.00 days	$1,300 /day	$31,200.00
2	GEOTECHNICAL ENGINEERING	40.00 days	$600 /day	$24,000.00
3	ENGINEERING DESIGN	120.00 days	$400 /day	$48,000.00
4	PROJECT MANAGEMENT	120.00 days	$500 /day	$60,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$27,840
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$27,840
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$142,004.11
10	RIGHT–OF–WAY PERSONNEL (per parcel)	L. Sum	$1,500	$0.00
11	RIGHT–OF–WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	0.1 acres	$12,000 /acres	$1,200.00
	GRAND TOTAL	TOTAL PROJECT COST:		$1,161,737.44

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 7

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW-1659-HB5-AA
DESCRIPTION: ALTERNATIVE M-3 Sedimentation Pond
PAGE 1 OF 2

DATE: 21-Dec-93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$7,596.40
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	0.3	acres	$3,650	/acres	$1,095.00
4	Excavation (Including haul off-site)	700.0	yd3	$8.25	/yd3	$5,775.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)	150.0	yd3	$15	/yd3	$2,250.00
7	Access Road (15' wide, 6" gravel depth)	160.0	l.f.	$17	/l.f.	$2,720.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)	100.00	ton	$20	/ton	$2,000.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)	90.0	ton	$27	/ton	$2,430.00
12	Hydroseeding	0.5	acres	$1,400	/acre	$700.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil	100.0	yd3	$27	/yd3	$2,700.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.	40.0	l.f.	$55	/l.f.	$2,200.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)	2	each	$3,400	/each	$6,800.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP-T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	Chain Link Fence (Type I)	450.0	l.f.	$15	/l.f.	$6,750.00
60	Chain Link Gate (14' wide)	1	each	$900	/each	$900.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$5,000	/lump	$5,000.00
62	Traffic Control	10.0	hour	$20	/hour	$200.00
63	Intake Structure		each	$8,000	/each	$0.00
64	Landscaping	1	lump	$12,000	/lump	$12,000.00
65	Ravine Fill		s.y	$6	/s.y.	$0.00
66	Rough Grading down slope		lump	$30,000	/lump	$0.00
67	Inlet Structure with Debris Barrier	1	lump	$55,000	/lump	$55,000.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$116,116.40
	SALES TAX 8.2%:	0.082	$9,521.54
	SUBTOTAL:		$125,637.94
	CONTINGENCY:	0.20	$25,127.59
TOTAL	CONSTRUCTION		$150,765.53

TABLE 7 (CONTINUED)

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–3
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	5.00 days	$1,300 /day	$6,500.00
2	GEOTECHNICAL ENGINEERING	4.00 days	$600 /day	$2,400.00
3	ENGINEERING DESIGN	75.00 days	$400 /day	$30,000.00
4	PROJECT MANAGEMENT	75.00 days	$500 /day	$37,500.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$14,800
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$14,800
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$33,639.84
10	RIGHT–OF–WAY PERSONNEL (per parcel)	3.00 L. Sum	$1,500	$4,500.00
11	RIGHT–OF–WAY COST (Residential Area)	0.3 acres	$40,000 /acres	$10,000.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	acres	$12,000 /acres	$0.00
	GRAND TOTAL	TOTAL PROJECT COST:		$304,905.38

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 8

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–4
PAGE 1 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$12,575.50
2	Clearing and grubbing (Light cover)	1.5	acres	$2,800	/acres	$4,200.00
3	Clearing and grubbing (Heavy cover)		acres	$3,650	/acres	$0.00
4	Excavation (Including haul off–site)	12000.0	yd3	$8.25	/yd3	$99,000.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)	400.0	yd3	$15	/yd3	$6,000.00
7	Access Road (15' wide, 6" gravel depth)	250.0	l.f.	$17	/l.f.	$4,250.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)		ton	$20	/ton	$0.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)	40.0	ton	$27	/ton	$1,080.00
12	Hydroseeding	1.5	acres	$1,400	/acre	$2,100.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.	60.0	l.f.	$97	/l.f.	$5,820.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)		each	$3,400	/each	$0.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP–T) Device		each	$2,000	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)	1	each	$11,000	/each	$11,000.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack	1	each	$500	/each	$500.00
59	Chain Link Fence (Type 1)	900.0	l.f.	$15	/l.f.	$13,500.00
60	Chain Link Gate (14' wide)	2	each	$900	/each	$1,800.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$10,000	/lump	$10,000.00
62	Traffic Control	20.0	hour	$20	/hour	$400.00
63	Gabion Sand Blanket		c.y.	$30	/c.y.	$0.00
64	Landscaping	1	lump	$15,000	/lump	$15,000.00
65	Overflow Bird Cage		each	$300	/each	$0.00
66	Rough Grading down slope	1	lump	$5,000	/lump	$5,000.00
67	Debris Barrier		each	$1,000	/each	$0.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$192,225.50
	SALES TAX 8.2%:	0.082	$15,762.49
	SUBTOTAL:		$207,987.99
	CONTINGENCY:	0.20	$41,597.60
TOTAL	CONSTRUCTION		$249,585.59

TABLE 8 (CONTINUED)

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–4
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	7.00 days	$1,300 /day	$9,100.00
2	GEOTECHNICAL ENGINEERING	6.00 days	$600 /day	$3,600.00
3	ENGINEERING DESIGN	80.00 days	$400 /day	$32,000.00
4	PROJECT MANAGEMENT	85.00 days	$500 /day	$42,500.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$16,720
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	X 20%	20% of design cost (1)	$0
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$50,142.79
10	RIGHT–OF–WAY PERSONNEL (per parcel)	4.00 L. Sum	$1,500	$6,000.00
11	RIGHT–OF–WAY COST (Residential Area)	1.5 acres	$40,000 /acres	$60,000.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	acres	$12,000 /acres	$0.00
	GRAND TOTAL	TOTAL PROJECT COST:		$469,648.38

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 9

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW-1659-HB5-AA
DESCRIPTION: ALTERNATIVE M-5 Tightline Flow Through Ravine
PAGE 1 OF 2

DATE: 21-Dec-93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$32,455.50
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	3.0	acres	$3,650	/acres	$10,950.00
4	Excavation (Including haul off-site)	2000.0	yd3	$8.25	/yd3	$16,500.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)		l.f.	$17	/l.f.	$0.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)		ton	$20	/ton	$0.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding	3.0	acres	$1,400	/acre	$4,200.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.	2800.0	l.f.	$67	/l.f.	$187,600.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)	4	each	$3,400	/each	$13,600.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP-T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	New Debris Barrier and Stream Entrance		each	$8,000	/each	$0.00
60	Remove and Replace Rockery		c.y	$150	/c.y	$0.00
61	Erosion Control Measures (Filter fence, etc...)	3.0	acres	$10,000	/acres	$30,000.00
62	Traffic Control	20.0	hour	$20	/hour	$400.00
63	Intake Structure	1	each	$8,000	/each	$8,000.00
64	Landscaping	3.0	acres	$5,000	/acres	$15,000.00
65	Ravine Fill	10000	c.y.	$6	/s.y.	$60,000.00
66	Temporary Access Road Construction	2800.0	l.f.	$40	/l.f.	$112,000.00
67	Pipe Anchors at 1 per 50 ft	54	each	$100	/each	$5,400.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$496,105.50
	SALES TAX 8.2%:	0.082	$40,680.65
	SUBTOTAL:		$536,786.15
	CONTINGENCY:	0.20	$107,357.23
TOTAL	CONSTRUCTION		$644,143.38

TABLE 9 (CONTINUED)

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–5 Bank Stabilization
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	24.00 days	$1,300 /day	$31,200.00
2	GEOTECHNICAL ENGINEERING	40.00 days	$600 /day	$24,000.00
3	ENGINEERING DESIGN	120.00 days	$400 /day	$48,000.00
4	PROJECT MANAGEMENT	120.00 days	$500 /day	$60,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$27,840
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$27,840
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$116,033.94
10	RIGHT–OF–WAY PERSONNEL (per parcel)	16.00 L. Sum	$1,500	$24,000.00
11	RIGHT–OF–WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	0.1 acres	$12,000 /acres	$1,200.00
	GRAND TOTAL	TOTAL PROJECT COST:		$1,004,257.33

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 10

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW-1659-HB5-AA
DESCRIPTION: ALTERNATIVE M-8 (WEST AND EAST DIVERSIONS)
PAGE 1 OF 2

DATE: 21-Dec-93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$25,966.50
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	1.4	acres	$3,650	/acres	$5,110.00
4	Excavation (Including haul off-site)	200.0	yd3	$8.25	/yd3	$1,650.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)	800.0	l.f.	$17	/l.f.	$13,600.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)	450.00	ton	$20	/ton	$9,000.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding	1.7	acres	$1,400	/acre	$2,380.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)	400.0	yd2	$22	/yd2	$8,800.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil	200.0	yd3	$27	/yd3	$5,400.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.	1584.0	l.f.	$45	/l.f.	$71,280.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.	80.0	l.f.	$36	/l.f.	$2,880.00
33	* 18" Dia. H.C.M.P.	800.0	l.f.	$40	/l.f.	$32,000.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.	1200.0	l.f.	$56	/l.f.	$67,200.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)	15	each	$1,200	/each	$18,000.00
49	48" Type II S.D.M.H. (<12 ft.)	12	each	$3,400	/each	$40,800.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP-T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	New Debris Rack/Inlet Improvements	1	lump	$10,000	/lump	$10,000.00
59	Rock lining for steep ditches	370	c.y	$25	/c.y	$9,250.00
60	Remove and Replace Rockery	50	c.y	$150	/c.y	$7,500.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$15,000	/lump	$15,000.00
62	Traffic Control	200.0	hour	$20	/hour	$4,000.00
63	Ditch widening	2500.0	l.f.	$5	/l.f.	$12,500.00
64	Landscaping	1	lump	$20,000	/lump	$20,000.00
65	Remove and Replace Existing Cement Concrete Sidewalk	100	s.y	$30	/s.y.	$3,000.00
66	Rough Grading down slope	1	lump	$10,000	/lump	$10,000.00
67	Pipe Anchors at 1 per 50 ft	16	each	$100	/each	$1,600.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$396,916.50
	SALES TAX 8.2%:	0.082	$32,547.15
	SUBTOTAL:		$429,463.65
	CONTINGENCY:	0.20	$85,892.73
TOTAL	CONSTRUCTION		$515,356.38

TABLE 10 (CONTINUED)

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE M–8 (WEST AND EAST DIVERSIONS)
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	20.00 days	$1,300 /day	$26,000.00
2	GEOTECHNICAL ENGINEERING	8.00 days	$500 /day	$4,000.00
3	ENGINEERING DESIGN	110.00 days	$400 /day	$44,000.00
4	PROJECT MANAGEMENT	100.00 days	$500 /day	$50,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$24,000
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	X 20%	20% of design cost (1)	$0
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$94,526.52
10	RIGHT–OF–WAY PERSONNEL (per parcel)	L. Sum	$1,500	$0.00
11	RIGHT–OF–WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	0.1 acres	$12,000 /acres	$1,200.00
	SUBTOTAL			$759,082.90
	SEDIMENTATION POND (ALT M–3)			$305,000
	GRAND TOTAL			$1,064,083

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 11

STUDY: QUINAULT ESTATE – MIDDLE RAVINE
PROJECT NO: WW-1659-HB5-AA
DESCRIPTION: ALTERNATIVE W-1
PAGE 1 OF 2

DATE: 21-Dec-93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$6,797.70
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	0.5	acres	$3,650	/acres	$1,825.00
4	Excavation (Including haul off-site)	60.0	yd3	$8.25	/yd3	$495.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)		l.f.	$17	/l.f.	$0.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)	450.00	ton	$20	/ton	$9,000.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding	0.5	acres	$1,400	/acre	$700.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)	60.0	yd2	$22	/yd2	$1,320.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil	20.0	yd3	$27	/yd3	$540.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.	80.0	l.f.	$36	/l.f.	$2,880.00
33	* 18" Dia. H.C.M.P.	820.0	l.f.	$40	/l.f.	$32,800.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)	7	each	$3,400	/each	$23,800.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP-T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	Chain Link Fence (Type 1)		l.f.	$15	/l.f.	$0.00
60	Remove and Replace Rockery	40	c.y	$150	/c.y	$6,000.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$5,000	/lump	$5,000.00
62	Traffic Control	20.0	hour	$20	/hour	$400.00
63	Extra Depth Trench		l.f.	$20	/l.f.	$0.00
64	Landscaping	1	lump	$5,000	/lump	$5,000.00
65	Remove and Replace Existing Cement Concrete Sidewalk	25	s.y	$30	/s.y.	$750.00
66	Rough Grading down slope	1	lump	$5,000	/lump	$5,000.00
67	Pipe Anchors at 1 per 50 ft	16	each	$100	/each	$1,600.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$103,907.70
	SALES TAX 8.2%:	0.082	$8,520.43
	SUBTOTAL:		$112,428.13
	CONTINGENCY:	0.20	$22,485.63
TOTAL	CONSTRUCTION		$134,913.76

TABLE 11 (CONTINUED)

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE W–1
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	4.00 days	$1,300 /day	$5,200.00
2	GEOTECHNICAL ENGINEERING	2.00 days	$600 /day	$1,200.00
3	ENGINEERING DESIGN	60.00 days	$400 /day	$24,000.00
4	PROJECT MANAGEMENT	60.00 days	$500 /day	$30,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$11,840
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$11,840
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$30,992.60
10	RIGHT–OF–WAY PERSONNEL (per parcel)	L. Sum	$1,500	$0.00
11	RIGHT–OF–WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	0.1 acres	$12,000 /acres	$1,200.00
	GRAND TOTAL		TOTAL PROJECT COST:	$251,186.36

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 12

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE W–2
PAGE 1 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$6,744.52
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	0.5	acres	$3,650	/acres	$1,885.33
4	Excavation (Including haul off–site)	500.0	yd3	$8.25	/yd3	$4,125.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)		l.f.	$17	/l.f.	$0.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)		ton	$20	/ton	$0.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding	1.0	acres	$1,400	/acre	$1,400.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil	20.0	yd3	$27	/yd3	$540.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)		each	$3,400	/each	$0.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP–T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	Chain Link Fence (Type 1)		l.f.	$15	/l.f.	$0.00
60	Debri barrier Improvements	1	lump	$6,000	/lump	$6,000.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$12,000	/lump	$12,000.00
62	Traffic Control	20.0	hour	$20	/hour	$400.00
63	Rip Rab Sand Blanket	200	c.y.	$30	/c.y.	$6,000.00
64	Landscaping	1	lump	$5,000	/lump	$5,000.00
65	Temporary access road	760	l.f.	$25	/l.f.	$19,000.00
66	Rough Grading down slope	1	lump	$10,000	/lump	$10,000.00
67	Rock Rip Rap	500	c.y.	$60	/c.y.	$30,000.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$103,094.85
	SALES TAX 8.2%:	0.082	$8,453.78
	SUBTOTAL:		$111,548.63
	CONTINGENCY:	0.20	$22,309.73
TOTAL	CONSTRUCTION		$133,858.36

TABLE 12 (CONTINUED)

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE W–2
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	5.00 days	$1,300 /day	$6,500.00
2	GEOTECHNICAL ENGINEERING	12.00 days	$500 /day	$6,000.00
3	ENGINEERING DESIGN	120.00 days	$200 /day	$24,000.00
4	PROJECT MANAGEMENT	120.00 days	$200 /day	$24,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$10,900
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$10,900
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$30,816.35
10	RIGHT–OF–WAY PERSONNEL (per parcel)	2.00 L. Sum	$1,500	$3,000.00
11	RIGHT–OF–WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	0.1 acres	$12,000 /acres	$1,200.00
	GRAND TOTAL		TOTAL PROJECT COST:	$251,174.70

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 13

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW-1659-HB5-AA
DESCRIPTION: ALTERNATIVE W-3
PAGE 1 OF 1

DATE: 21-Dec-93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$1,649.73
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	0.1	acres	$3,650	/acres	$365.00
4	Excavation (Including haul off-site)	50.0	yd3	$8.25	/yd3	$412.50
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)	10.0	yd3	$15	/yd3	$150.00
7	Access Road (15' wide, 6" gravel depth)		l.f.	$17	/l.f.	$0.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)		ton	$20	/ton	$0.00
10	Streambed Gravel (1.7 tons/yd3)	20.00	ton	$27	/ton	$540.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding		acres	$1,400	/acre	$0.00
13	Gabions (with road access)	32.0	yd3	$175	/yd3	$5,600.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.	22.0	l.f.	$50	/l.f.	$1,100.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)	2	each	$3,400	/each	$6,800.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP-T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	Chain Link Fence (Type 1)		l.f.	$15	/l.f.	$0.00
60	Chain Link Gate (14' wide)		each	$900	/each	$0.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$2,000	/lump	$2,000.00
62	Traffic Control	10.0	hour	$20	/hour	$200.00
63	Gabion Sand Blanket	20	c.y.	$30	/c.y.	$600.00
64	Landscaping	1	lump	$2,000	/lump	$2,000.00
65	Overflow Bird Cage	1	each	$300	/each	$300.00
66	Rough Grading down slope	1	lump	$2,000	/lump	$2,000.00
67	Debris Barrier	1	each	$1,500	/each	$1,500.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$25,217.23
	SALES TAX 8.2%:	0.082	$2,067.81
	SUBTOTAL:		$27,285.04
	CONTINGENCY:	0.20	$5,457.01
TOTAL	CONSTRUCTION		$32,742.04

Note: This project would consist of a Small CIP and includes construction costs only.

TABLE 14

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE W–4
PAGE 1 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$12,280.10
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	1.0	acres	$3,650	/acres	$3,650.00
4	Excavation (Including haul off–site)	14000.0	yd3	$8.25	/yd3	$115,500.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)	500.0	yd3	$15	/yd3	$7,500.00
7	Access Road (15' wide, 6" gravel depth)	100.0	l.f.	$17	/l.f.	$1,700.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)		ton	$20	/ton	$0.00
10	Streambed Gravel (1.7 tons/yd3)	20.00	ton	$27	/ton	$540.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding	1.0	acres	$1,400	/acre	$1,400.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.	60.0	l.f.	$40	/l.f.	$2,400.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)	1	each	$3,400	/each	$3,400.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP–T) Device	1	each	$840	/each	$840.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack	1	each	$500	/each	$500.00
59	Chain Link Fence (Type 1)	740.0	l.f.	$15	/l.f.	$11,100.00
60	Chain Link Gate (14' wide)	1	each	$900	/each	$900.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$8,000	/lump	$8,000.00
62	Traffic Control		hour	$20	/hour	$0.00
63	Gabion Sand Blanket		c.y.	$30	/c.y.	$0.00
64	Landscaping	1	lump	$5,000	/lump	$5,000.00
65	Overflow Bird Cage		each	$300	/each	$0.00
66	Rough Grading down slope	1	lump	$5,000	/lump	$5,000.00
67	Debris Barrier at NE 169th Street	1	lump	$8,000	/lump	$8,000.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$187,710.10
	SALES TAX 8.2%:	0.082	$15,392.23
	SUBTOTAL:		$203,102.33
	CONTINGENCY:	0.20	$40,620.47
TOTAL	CONSTRUCTION		$243,722.79

TABLE 14 (CONTINUED)

STUDY: QUINAULT ESTATE – WEST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE W–4
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	4.00 days	$1,300 /day	$5,200.00
2	GEOTECHNICAL ENGINEERING	2.00 days	$500 /day	$1,000.00
3	ENGINEERING DESIGN	70.00 days	$400 /day	$28,000.00
4	PROJECT MANAGEMENT	70.00 days	$500 /day	$35,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$13,640
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$13,640
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$49,163.71
10	RIGHT–OF–WAY PERSONNEL (per parcel)	3.00 L. Sum	$1,500	$4,500.00
11	RIGHT–OF–WAY COST (Residential Area)	1.0 acres	$40,000 /acres	$40,000.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	acres	$12,000 /acres	$0.00
	GRAND TOTAL		TOTAL PROJECT COST:	$433,866.50

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 15

STUDY: QUINAULT ESTATE – EAST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE E–1
PAGE 1 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$5,897.15
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	0.4	acres	$3,650	/acres	$1,460.00
4	Excavation (Including haul off–site)	200.0	yd3	$8.25	/yd3	$1,650.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)	400.0	l.f.	$17	/l.f.	$6,800.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)		ton	$20	/ton	$0.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding	0.4	acres	$1,400	/acre	$560.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)	33.0	yd3	$275	/yd3	$9,075.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.	450.0	l.f.	$56	/l.f.	$25,200.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)	1	each	$3,400	/each	$3,400.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP–T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	Chain Link Fence (Type 1)		l.f.	$15	/l.f.	$0.00
60	Remove and Replace Rockery		c.y	$150	/c.y	$0.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$10,000	/lump	$10,000.00
62	Traffic Control	10.0	hour	$20	/hour	$200.00
63	Extra Depth Trench		l.f.	$20	/l.f.	$0.00
64	Landscaping	1	lump	$5,000	/lump	$5,000.00
65	Remove and Replace Existing Cement Concrete Sidewalk		s.y	$30	/s.y.	$0.00
66	Rough Grading down slope	1	lump	$20,000	/lump	$20,000.00
67	Pipe Anchors at 1 per 50 ft	9	each	$100	/each	$900.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$90,142.15
	SALES TAX 8.2%:	0.082	$7,391.66
	SUBTOTAL:		$97,533.81
	CONTINGENCY:	0.20	$19,506.76
TOTAL	CONSTRUCTION		$117,040.57

TABLE 15 (CONTINUED)

STUDY: QUINAULT ESTATE – EAST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE E–1
PAGE 2 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	14.00 days	$1,300 /day	$18,200.00
2	GEOTECHNICAL ENGINEERING	8.00 days	$600 /day	$4,800.00
3	ENGINEERING DESIGN	30.00 days	$400 /day	$12,000.00
4	PROJECT MANAGEMENT	30.00 days	$500 /day	$15,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$9,040
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$9,040
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$28,007.77
10	RIGHT–OF–WAY PERSONNEL (per parcel)	L. Sum	$1,500	$0.00
11	RIGHT–OF–WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	0.1 acres	$12,000 /acres	$1,200.00
	GRAND TOTAL	TOTAL PROJECT COST:		$214,328.34

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 16

STUDY: QUINAULT ESTATE - EAST RAVINE
PROJECT NO: WW-1659-HB5-AA
DESCRIPTION: ALTERNATIVE E-3
PAGE 1 OF 2

DATE: 02-Dec-93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$5,833.10
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	0.2	acres	$3,650	/acres	$730.00
4	Excavation (Including haul off-site)	200.0	yd3	$8.25	/yd3	$1,650.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)	60.0	l.f.	$17	/l.f.	$1,020.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)		ton	$20	/ton	$0.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)	20.0	ton	$27	/ton	$540.00
12	Hydroseeding	0.1	acres	$1,400	/acre	$140.00
13	Gabions (with road access)	100.0	yd3	$175	/yd3	$17,500.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.		l.f.	$40	/l.f.	$0.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.	450.0	l.f.	$56	/l.f.	$25,200.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)	3	each	$1,200	/each	$3,600.00
49	48" Type II S.D.M.H. (<12 ft.)		each	$3,400	/each	$0.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP-T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	Chain Link Fence (Type 1)		l.f.	$15	/l.f.	$0.00
60	Remove and Replace Rockery		c.y	$150	/c.y	$0.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$8,000	/lump	$8,000.00
62	Traffic Control	10.0	hour	$20	/hour	$200.00
63	Energy Dissipator	1	lump	$8,000	/lump	$8,000.00
64	Landscaping	1	lump	$5,000	/lump	$5,000.00
65	Guard Rail	35.0	l.f.	$50	/l.f.	$1,750.00
66	Rough Grading down slope	1	lump	$5,000	/lump	$5,000.00
67	New Debris Rack	1	lump	$5,000	/lump	$5,000.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$89,163.10
	SALES TAX 8.2%:	0.082	$7,311.37
	SUBTOTAL:		$96,474.47
	CONTINGENCY:	0.20	$19,294.89
TOTAL	CONSTRUCTION		$115,769.37

TABLE 16 (CONTINUED)

STUDY: QUINAULT ESTATE – EAST RAVINE
PROJECT NO: WW-1659-HB5-AA
DESCRIPTION: ALTERNATIVE E-3
PAGE 2 OF 2

DATE: 02-Dec-93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	5.00 days	$1,300 /day	$6,500.00
2	GEOTECHNICAL ENGINEERING	5.00 days	$600 /day	$3,000.00
3	ENGINEERING DESIGN	50.00 days	$400 /day	$20,000.00
4	PROJECT MANAGEMENT	50.00 days	$500 /day	$25,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$10,300
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$10,300
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$27,795.48
10	RIGHT-OF-WAY PERSONNEL (per parcel)	2.00 L. Sum	$1,500	$3,000.00
11	RIGHT-OF-WAY COST (Residential Area)	0.1 acres	$40,000 /acres	$4,000.00
12	RIGHT-OF-WAY COST (Easement Aquisition Only)	acres	$12,000 /acres	$0.00
	GRAND TOTAL		TOTAL PROJECT COST:	$225,664.85

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 17

STUDY: QUINAULT ESTATE – EAST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE E–4
PAGE 1 OF 2

DATE: 21–Dec–93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$4,986.10
2	Clearing and grubbing (Light cover)		acres	$2,800	/acres	$0.00
3	Clearing and grubbing (Heavy cover)	0.4	acres	$3,650	/acres	$1,460.00
4	Excavation (Including haul off–site)	3000.0	yd3	$8.25	/yd3	$24,750.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)	60.0	l.f.	$17	/l.f.	$1,020.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)		ton	$20	/ton	$0.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding	0.4	acres	$1,400	/acre	$560.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)		yd2	$22	/yd2	$0.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.	50.0	l.f.	$40	/l.f.	$2,000.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 12" Dia. H.D.P.P.		l.f.	$56	/l.f.	$0.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)		each	$1,200	/each	$0.00
49	48" Type II S.D.M.H. (<12 ft.)	1	each	$3,400	/each	$3,400.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP–T) Device	1	each	$840	/each	$840.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack	1	each	$500	/each	$500.00
59	Chain Link Fence (Type 1)	100.0	l.f.	$15	/l.f.	$1,500.00
60	Remove and Replace Rockery		c.y	$150	/c.y	$0.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$15,000	/lump	$15,000.00
62	Traffic Control	10.0	hour	$20	/hour	$200.00
63	Extra Depth Trench		l.f.	$20	/l.f.	$0.00
64	Landscaping	1	lump	$10,000	/lump	$10,000.00
65	Remove and Replace Existing Cement Concrete Sidewalk		s.y	$30	/s.y.	$0.00
66	Rough Grading down slope	1	lump	$10,000	/lump	$10,000.00
67	Pipe Anchors at 1 per 50 ft		each	$100	/each	$0.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$76,216.10
	SALES TAX 8.2%:	0.082	$6,249.72
	SUBTOTAL:		$82,465.82
	CONTINGENCY:	0.20	$16,493.16
TOTAL	CONSTRUCTION		$98,958.98

TABLE 17 (CONTINUED)

STUDY: QUINAULT ESTATE – EAST RAVINE
PROJECT NO: WW-1659-HB5-AA
DESCRIPTION: ALTERNATIVE E-4
PAGE 2 OF 2

DATE: 21-Dec-93
ESTIMATOR: MSG

NUMBER	OTHER COSTS			PERCENT
1	SURVEYING	10.00 days	$1,300 /day	$13,000.00
2	GEOTECHNICAL ENGINEERING	8.00 days	$600 /day	$4,800.00
3	ENGINEERING DESIGN	40.00 days	$400 /day	$16,000.00
4	PROJECT MANAGEMENT	35.00 days	$500 /day	$17,500.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$9,300
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	X 20%	20% of design cost (1)	$0
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$24,988.15
10	RIGHT-OF-WAY PERSONNEL (per parcel)	L. Sum	$1,500	$0.00
11	RIGHT-OF-WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT-OF-WAY COST (Easement Aquisition Only)	0.1 acres	$12,000 /acres	$1,200.00
	GRAND TOTAL	TOTAL PROJECT COST:		$185,747.13

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

TABLE 18

STUDY: QUINAULT ESTATE – EAST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE E–5
PAGE 1 OF 2

DATE: 02–Dec–93
ESTIMATOR: MSG

ITEM NO.	ITEM DESCRIPTION (In place)	QUANTITY	UNITS	UNIT COST	$/UNIT	COST
1	Mobilization	1	sum	0.07	% of sum	$7,568.40
2	Clearing and grubbing (Light cover)	0.1	acres	$2,800	/acres	$140.00
3	Clearing and grubbing (Heavy cover)		acres	$3,650	/acres	$0.00
4	Excavation (Including haul off–site)		yd3	$8.25	/yd3	$0.00
5	Embankment Compaction		yd3	$2	/yd3	$0.00
6	Structural Fill (Including compaction)		yd3	$15	/yd3	$0.00
7	Access Road (15' wide, 6" gravel depth)		l.f.	$17	/l.f.	$0.00
8	Gravel, Class B		ton	$20	/ton	$0.00
9	Gravel, crushed rock (1.85 tons/yd3)	50.00	ton	$20	/ton	$1,000.00
10	Streambed Gravel (1.7 tons/yd3)		ton	$27	/ton	$0.00
11	Rip Rap (1.6 tons/yd3)		ton	$27	/ton	$0.00
12	Hydroseeding	0.3	acres	$1,400	/acre	$420.00
13	Gabions (with road access)		yd3	$175	/yd3	$0.00
14	Gabions (without road access)		yd3	$275	/yd3	$0.00
15	Asphalt Patching (incl. crushed rock)	180.0	yd2	$22	/yd2	$3,960.00
16	Extruded Asphalt Curb		l.f.	$6	/l.f.	$0.00
17	Topsoil		yd3	$27	/yd3	$0.00
18	Concrete Class A (Includes forms and rebar)		yd3	$1,600	/yd3	$0.00
19	* 12" Dia. R.C.P.	220.0	l.f.	$40	/l.f.	$8,800.00
20	* 18" Dia. R.C.P.		l.f.	$45	/l.f.	$0.00
21	* 24" Dia. R.C.P.		l.f.	$55	/l.f.	$0.00
22	* 30" Dia. R.C.P.		l.f.	$84	/l.f.	$0.00
23	* 36" Dia. R.C.P.		l.f.	$97	/l.f.	$0.00
24	* 42" Dia. R.C.P		l.f.	$127	/l.f.	$0.00
25	* 48" Dia. R.C.P.		l.f.	$150	/l.f.	$0.00
26	* 54" Dia. R.C.P.		l.f.	$175	/l.f.	$0.00
27	* 60" Dia. R.C.P.		l.f.	$215	/l.f.	$0.00
28	* 72" Dia. R.C.P.		l.f.	$300	/l.f.	$0.00
29	* 84" Dia. R.C.P.		l.f.	$350	/l.f.	$0.00
30	* 96" Dia. R.C.P.		l.f.	$475	/l.f.	$0.00
31	*108" Dia. R.C.P.		l.f.	$615	/l.f.	$0.00
32	* 12" Dia. H.C.M.P.		l.f.	$36	/l.f.	$0.00
33	* 18" Dia. H.C.M.P.		l.f.	$40	/l.f.	$0.00
34	* 24" Dia. H.C.M.P.		l.f.	$50	/l.f.	$0.00
35	* 30" Dia. H.C.M.P.		l.f.	$64	/l.f.	$0.00
36	* 36" Dia. H.C.M.P.		l.f.	$72	/l.f.	$0.00
37	* 42" Dia. H.C.M.P.		l.f.	$90	/l.f.	$0.00
38	* 48" Dia. H.C.M.P.		l.f.	$100	/l.f.	$0.00
39	* 54" Dia. H.C.M.P.		l.f.	$105	/l.f.	$0.00
40	* 60" Dia. H.C.M.P.		l.f.	$110	/l.f.	$0.00
41	* 72" Dia. H.C.M.P.		l.f.	$140	/l.f.	$0.00
42	* 84" Dia. H.C.M.P.		l.f.	$161	/l.f.	$0.00
43	* 96" Dia. H.C.M.P.		l.f.	$195	/l.f.	$0.00
44	*108" Dia. H.C.M.P.		l.f.	$250	/l.f.	$0.00
45	* 8" Dia. H.D.P.P.	1200.0	l.f.	$40	/l.f.	$48,000.00
46	* 18" Dia. H.D.P.P.		l.f.	$67	/l.f.	$0.00
47	* 24" Dia. H.D.P.P.		l.f.	$90	/l.f.	$0.00
48	Type I C.B. (To 5' depth, pipe to 18" dia.)	3	each	$1,200	/each	$3,600.00
49	48" Type II S.D.M.H. (<12 ft.)	5	each	$3,400	/each	$17,000.00
50	48" Type II S.D.M.H. (>12 ft.)		each	$4,500	/each	$0.00
51	54" Type II S.D.M.H. (<12 ft.)		each	$4,000	/each	$0.00
52	54" Type II S.D.M.H. (>12 ft.)		each	$5,000	/each	$0.00
53	72" Type II S.D.M.H. (<12 ft.)		each	$5,500	/each	$0.00
54	96" Type II S.D.M.H. (<12 ft.)		each	$9,000	/each	$0.00
55	Flow Controller (FROP–T) Device		each	$840	/each	$0.00
56	96" Flow Controller Manhole (<12 ft.)		each	$23,000	/each	$0.00
57	96" Flow Controller Manhole (>12 ft.)		each	$34,000	/each	$0.00
58	Trash Rack		each	$500	/each	$0.00
59	Chain Link Fence (Type 1)		l.f.	$15	/l.f.	$0.00
60	Remove and Replace Rockery		c.y	$150	/c.y	$0.00
61	Erosion Control Measures (Filter fence, etc...)	1	lump	$10,000	/lump	$10,000.00
62	Traffic Control	10.0	hour	$20	/hour	$200.00
63	Energy Dissipator		lump	$4,000	/lump	$0.00
64	Landscaping	1	lump	$5,000	/lump	$5,000.00
65	Guard Rail		l.f.	$50	/l.f.	$0.00
66	Rough Grading down slope		lump	$5,000	/lump	$0.00
67	New Debris Rack/Inlet Improvements	1	lump	$10,000	/lump	$10,000.00

* Pipe estimate includes: Material, excavation, shoring, installation, bedding, backfill, compaction, restoration. This cost assumes a min. 6 ft. trench depth or 2 ft. of cover over the top of the pipe.

	SUBTOTAL:		$115,688.40
	SALES TAX 8.2%:	0.082	$9,486.45
	SUBTOTAL:		$125,174.85
	CONTINGENCY:	0.20	$25,034.97
TOTAL	CONSTRUCTION		$150,209.82

TABLE 18 (CONTINUED)

STUDY: QUINAULT ESTATE – EAST RAVINE
PROJECT NO: WW–1659–HB5–AA
DESCRIPTION: ALTERNATIVE E–5
PAGE 2 OF 2

DATE: 02–Dec–93
ESTIMATOR: MSG

NUMBER	OTHER COSTS		PERCENT	
1	SURVEYING	10.00 days	$1,300 /day	$13,000.00
2	GEOTECHNICAL ENGINEERING	12.00 days	$600 /day	$7,200.00
3	ENGINEERING DESIGN	45.00 days	$400 /day	$18,000.00
4	PROJECT MANAGEMENT	40.00 days	$500 /day	$20,000.00
5	SENSITIVE AREA (if yes add 1)	1 X 20%	20% of design cost (1)	$10,200
6	EIS REQUIRED (if yes add 1)	X 50%	50% of design cost (1)	$0
7	PERMITS REQUIRED (if yes add 1)	1 X 20%	20% of design cost (1)	$10,200
8	CONSULTANT DESIGN (if yes add 1)	X 150%	150% of design cost (2)	$0
9	C.M.&I.	L. Sum	$8,462 + 16.702%	$33,547.04
10	RIGHT–OF–WAY PERSONNEL (per parcel)	3.00 L. Sum	$1,500	$4,500.00
11	RIGHT–OF–WAY COST (Residential Area)	acres	$40,000 /acres	$0.00
12	RIGHT–OF–WAY COST (Easement Aquisition Only)	0.30 acres	$12,000 /acres	$3,600.00
	GRAND TOTAL	TOTAL PROJECT COST:		$270,456.86

Notes

(1) Treats design cost as surveying, engineering design, and project management
(2) Treats design cost as surveying plus engineering design

SECTION VI

RECOMMENDED SOLUTIONS

A. RECOMMENDED SOLUTIONS

1. General

Quinault Estates is located on an alluvial fan at the mouth of the middle and east ravines. The alluvial fan was formed by repeated episodes of flooding and sediment deposition during historic and prehistoric times. The fact that the Quinault Estates development was placed on the alluvial fan where large episodic sediment deposition can occur was unfortunate. In addition, the downstream pipe drainage systems were not designed to accommodate large sediment loads.

Evidence that the erosion and sediment deposition is naturally occurring can be seen in the upper (east) branch of the east ravine. The tributary areas to this branch are only minimally developed, yet erosion and slope failures are currently active.

The best scenario would have been to avoid development on an active alluvial fan. However, because Quinault Estates is already developed and subject to recurrent problems, significant structural solutions will be necessary to solve these problems. It should be noted that erosion and sedimentation will continue, albeit at a much reduced rate. Because of the nature of flooding as a result of debris blockage at pipe entrances, there is still the potential for overflows even if the recommended solutions are implemented. The selection of the preferred solutions have been coordinated with County staff during the investigation.

2. Middle Ravine Recommended Solution

There are two primary alternatives worth serious consideration, Alternative M-1 (diversion) and Alternative M-3 (sedimentation pond). The primary drawbacks of other alternatives are listed below:

- **NO ACTION**: The County has had recurrent problems with this ravine, most notably from the July 13 event. Without corrective action, major problems will continue.

- **ALTERNATIVE M-2** - Bank Stabilization: Instability of the ravine sideslopes would make streambank stabilization very difficult and costly.

- **ALTERNATIVE M-4** - Detention: Detention would not solve the problem because runoff volumes would not be reduced, and only moderate peak flow attenuation would result.

- **ALTERNATIVE M-5** - Tightline in Ravine: Ravine access and instability problems make this alternative extremely difficult to construct.

- **ALTERNATIVE M-6** - Pipe Inlet Improvements and Additional Sediment Vault: Inlet improvements would not be adequate to allow conveyance of the high sediment load; this alternative would not work.

- **ALTERNATIVE M-7** - Small Sediment Pond and Concrete Channel to Sammamish River: A small sediment pond would be ineffective. In addition, this alternative would encourage sediment transport to the Sammamish River which would probably not be acceptable to the Washington Department of Fisheries.

- **ALTERNATIVE M-8** - Divert Runoff from Inglemoor High School to the East Ravine and Moorland Elementary to the West Ravine plus a Sediment Pond: This alternative includes solving all three ravine problems. It would cost about the same as Alternative M-1 plus Alternative E-5 (the preferred solutions for all three ravines). It has the disadvantage of constructing a sediment pond at the base of the middle ravine. The disadvantages of a sediment pond are more thoroughly discussed in the following paragraphs.

When comparing Alternatives M-1 versus M-3, Alternative M-1 is preferred. The only apparent advantage M-3 has compared to M-1 is cost; $305,000 versus $825,000, respectively. However, this is not a direct cost comparison because the M-1 Alternative also solves the west ravine problem. The preferred solution for the west ravine problem is a tightline down 84th Avenue NE (W-1). The cost of this alternative is $251,000. Therefore, if the cost for W-1 is subtracted from the cost of M-1, the real cost comparison would be $305,000 versus $574,000. This is still a significant cost difference.

This cost difference is outweighed by several advantages the diversion (M-1) has over a sediment pond (M-3). The advantages of the tightline diversion (M-1) include:

a. The tightline provides greater protection and reliability against flooding and sediment deposition in Quinault Estates. With the sediment pond, there would be a greater risk of failure during large storms such as the July 13 event. A 500 cubic yard sediment pond would not have been adequate during the July 13 event.

   It could be possible to construct a larger sediment pond that would have greater reliability. For example, a 700-cubic-yard sediment pond could be constructed using gabions. This pond would be 6 feet deep and would have the same footprint as the sediment pond shown in Figure 9. However, the 700-cubic-yard sediment pond would require more expensive construction. With this pond, the cost for solving the middle ravine problem would be similar to the preferred alternative, M-1.

   Assuming that the sediment pond could provide a level of protection, similar to the diversion for the same cost, the diversion would still be preferred due to other considerations discussed below.

b. By reducing flows in the stream, the tightline alternative would create a greater reduction in fine-grained materials being deposited in the Sammamish River than the sediment pond alternative. The sieve analysis of the middle ravine soils

indicates that 90 percent of the Transitional Beds is smaller than a 200 sieve. The sediment pond would not be large enough to adequately reduce velocities and capture fine-grained materials eroded and transported by the high flows.

c. By reducing the storm runoff, the existing degraded riparian vegetation would be enhanced. The riparian vegetation has been essentially blown out during storms. Reducing flows would benefit riparian vegetation, which would then help the stream banks to resist erosion. By diverting the upper urbanized basin away from the ravine, the stream flows would approach their original natural regime prior to upstream development. Groundwater inflow to the ravine would not be affected.

d. The diversion corrects the problem at its source, whereas a sediment pond treats a symptom.

e. The sediment pond would require long-term maintenance.

f. Constructing a large sediment pond versus pipe inlet/debris barrier improvements at the bottom of the middle ravine (as included in the tightline alternative) would require more property acquisition and greater impact to the adjacent properties.

g. There could be greater permitting issues associated with sediment ponds.

The tightline alternative has fewer disadvantages than the sediment pond. The only disadvantage of the tightline route, other than the high cost, is the deep trench required along Simonds Road NE (approximately 700 feet in a 12 foot deep trench).

To implement Alternative M-1, permanent easements would be required along the 84th Avenue NE extension. Construction easements would also be required along Simonds Road NE. A pipeline alignment along the north side Simonds Road NE outside the paved section was selected to reduce roadway restoration costs and interference with an existing waterline near the north curb. This alignment would require removal and restoration of approximately 350 linear feet of rock wall as well as other landscape restoration. During design, alternative alignments should be considered to minimize restoration requirements and overall project costs.

The alignment along 84th Avenue NE could be on either side of the street. Utility interferences include a 24-inch water transmission main, a 12-inch water line, a gas line, and existing storm drains. In addition, the Northshore Utility District is currently planning to construct a sewer main in 1994. The location of existing utilities and preliminary alignment of this sewer is illustrated on Figure 7A.

The hydrologic effects of this alternative were described in detail in Section V. The methodology for developing the HYD model included an adjustment to account for the portion of residential areas that have non-effective impervious area. Such non-effective impervious areas produce lower runoff volumes. This adjustment was described in Section III. This method, while considered to be more realistic, is not in strict adherence

to the 1990 Design Manual. The Manual specifies that CN's be developed assuming all impervious areas are 100 percent effective (connected to the drainage system).

The HYD models for the selected alternatives were revised to be in strict adherence to the Manual. The results for Alternative M-1, as well as east ravine Alternative E-5, are given in Table 19. This table shows the HYD model results using both methods. The simulated flows using 100 percent effective impervious areas are only slightly higher (3 to 6 percent) than the flows with the non-effective area adjustment. The resulting flows simulated in strict compliance with the Manual do not change the sizing or extent of required improvements previously described. During design of improvements, the higher flows should be used.

3. West Ravine Recommended Solution

The selection of Alternative M-1 for the middle ravine includes the tightline along 84th Avenue NE which also solves the west ravine problem. Therefore, none of the stand-alone west ravine alternatives are selected. If for some reason Alternative M-1 could not be implemented, Alternative W-1 would be the preferred solution. Alternative W-2 (bank stabilization) would be as costly as Alternative W-1, but would be more difficult to construct and less reliable. Alternative W-3 (small sediment pond) may not completely solve the problem because of inadequate sediment storage volume. Alternative W-4 (stormwater detention) would be much more costly than Alternative W-1 and would allow minor erosion to continue. Alternative W-5 (diverting flow to the far west ravine) would exacerbate an existing problem and would expose the County to additional liability.

4. East Ravine Recommended Solution

The solution for the east ravine must not only address the sediment deposition and flooding problem in Quinault Estates but also the large failure on the 88th Avenue Branch. In the last 30 years, this large failure has supplied approximately 3,200 cubic yards of material. In addition, as the failure has continued to enlarge, it is approaching an existing sanitary sewer line. If the surface runoff to this branch is not addressed, the failure will continue to expand and threaten the integrity of the adjacent sewer.

There are two primary alternatives worth serious consideration, Alternatives E-3 (sediment pond and short tightline around the failure) and E-5 (tightlining the 88th Avenue Branch along existing sewer). The primary drawbacks of other alternatives are listed below:

- **NO ACTION** - The County has had recurrent problems with this ravine. Without corrective action, problems will continue. In addition, the 88th Avenue Branch failures could threaten the integrity of the existing adjacent sewer line.

- **ALTERNATIVE E-1** - Divert 88th Avenue Branch to Middle Ravine: This was only considered a viable option if the middle ravine solution included a tightline (Alternative M-5). Otherwise, the middle ravine problem would be made worse by the diversion.

QUINAULT ESTATES

TABLE 19

HYDROLOGIC RESULTS OF SELECTED ALTERNATIVES
WITH RESIDENTIAL AREAS ASSUMED TO HAVE 100% EFFECTIVE IMPERVIOUS AREA

Alternative	Node	100–Year – 1990 CN Peak flow (cfs) w/ 100% Eff. Imp. (1)	100–Year – 1990 CN Peak flow (cfs) w/ Eff. Imp. Reductions (2)
M–1	I	20.9	19.7
	WC	30.1	29
	WF	33.1	31.7
	M	11.1	10.6
E–5	EB	4.8	4.6
	EC	3.7	3.6
	ED	9.3	9.0

Notes (1) CNs for residential areas developed assuming 100% effective impervious area.

(2) CNs for residential areas developed with effective impervious area reductions as described in Section III.

- **ALTERNATIVE E-2** - Bank Stabilization with check dams and short 88th Avenue Branch Diversion: This alternative provides insufficient sediment storage volume. The volume is also less than Alternative E-3 (sediment pond), but is as costly.

- **ALTERNATIVE E-4** - Upstream Detention: This alternative would not reduce flows sufficiently to solve the problem.

In comparing Alternatives E-3 and E-5, Alternative E-5 is preferred. While Alternative E-5 is more costly, it would be easier to construct. Construction issues with both alternatives include:

Alternative E-3

- The short diversion would include difficult construction down the steep unstable slopes of the ravine.

- An energy dissipator or manhole would be required at the end of the pipeline where the short diversion discharges to the stream.

- If the tightline was to be a surface installation, vandalism may be a problem.

- The sediment pond would be excavated into the ravine hillslope which may not be stable.

Alternative E-5

- Installing the tightline along the existing sewer line would require careful construction.

- One or two reaches of the tightline would be difficult construction on the very steep and narrow ridge. However, the tightline alongside the sewer appears to be easier construction than the short diversion of the 88th Avenue Branch to the stream (Alternative E-2).

- The longer tightline (Alternative E-5) requires a longer easement than the short tightline (Alternative E-2).

Both of the alternatives are considered reliable. However, Alternative E-5 is considered more reliable because it would reduce much of the flow into the ravine and, therefore, the stream's capacity to transport heavy sediment loads. By reducing ravine flows, Alternative E-5 would also provide greater reduction in the fine-grained material being transported to the Sammamish River.

Both alternatives would remove flow from the failure. The difference is that Alternative E-3 returns the flows to the middle and lower reaches of the ravine, allowing significant sediment transport. Part of the sediment load would then be trapped in the sediment pond. The Alternative E-5 tightline would carry flows completely around the failure, middle ravine and lower ravine.

Many of the other pros and cons of tightlining versus sediment pond that were discussed under the middle ravine alternative selection are also appropriate here. In brief, they include:

- By reducing the stream flows, the existing degraded habitat would be re-established.
- The diversion would correct the problem at its source, whereas a sediment pond would treat the symptom.
- The sediment pond would require long term maintenance.
- Constructing the sediment pond (Alternative E-3) versus pipe inlet/debris barrier improvements (Alternative E-5) at the bottom of the ravine would require more property acquisition and greater impact to the adjacent properties.
- There tends to be greater permitting issues associated with sediment ponds.

Even with the implementation of Alternative E-5, there would continue to be flows in the ravine from the upper (east) branch. Therefore, some minor erosion and sediment transport would continue. Minor inlet and debris barrier improvements at the pipe system inlet are included in this alternative to provide additional protection from debris plugging. With these considerations, Alternative E-5 is recommended to solve the east ravine problems.

B. INTERIM MEASURES

There are some interim measures that have already been implemented on the middle ravine. One includes a debris barrier crossing the stream about 50 to 100 feet upstream of the pipe system inlet. Other interim measures that should be considered include:

a. Excavating the lower 70 to 80 feet of the middle ravine (Station 0+00 to 0+80). This stream section was aggraded during the July 13 event and has lost substantial flow capacity. Even with relatively small floods, overbank flow will occur, and adjacent residences may be flooded (see Photograph 3).

b. If the middle ravine solution is not implemented for some time, consideration should be given to a more sophisticated inlet and debris barrier. The open area of the debris rack should be 10 to 20 times the area of the culvert opening. To increase the inlet capacity, the improvement should also increase the allowable headwater depth before overtopping occurs.

c. Special drainage standards for this area are in place and appropriate. The basin is currently designated as part of the Northshore Critical Drainage Area, which requires development to meet very high detention standards, or provide tightlines for undetained flows.

d. The pipe inlet to the west ravine could be improved with a larger debris barrier.

C. RELATED ISSUES

1. Other Ravine Erosion Problems

The Quinault Estate erosion problems are typical of other County ravine erosion problems. Others located the area include a ravine located approximately 800 feet to the west of the west ravine (referred to in this report as the far west ravine) and the Wildcliff Shores Condominium located in the vicinity of 77th Avenue NE and NE 170th Street. Both have had claims associated with flooding.

Implementing stormwater diversions for the Quinault Estates ravine problems may set a precedent for solving other ravine erosion problems, including those for which the County bears little legal responsibility or fault. Stormwater diversions can be a good solution but are often more costly than other types of solutions, such as sediment ponds.

2. Far West Ravine

As mentioned above, the County has received claims associated with flooding on the far west ravine. Although this problem was not investigated as a part of this study, the solution to the west and middle ravine problem (Alternative M-1) may provide an opportunity to solve the far west ravine problem. It may be possible to divert flows from the upper basin of the far west ravine to the Alternative M-1 tightline system.

County SWM staff conducted a preliminary site reconnaissance of the far west ravine and estimated that flows tributary to NE 166th Street could be diverted east along NE 166th Street to the proposed Alternative M-1 tightline. Such a diversion would probably require some deep trench excavation (about 15 feet).

If this diversion were considered, the County would probably have to upgrade the lowest, 150-foot section of 24-inch-diameter pipe of the existing west ravine pipe system which discharges to the Sammamish River.

3. Tightline Funding Participation

The County is currently exploring the (Alternative E-5) possibility of funding participation in the east ravine tightline by the developers of the proposed plat of The Park at Inglemoor. This is a 24-lot subdivision that will occupy tax lots 48 and 34, just north of the Ome Daiber Addition on 88th Avenue NE. The development could contribute to tightline construction in lieu of constructing a detention pond for the east basin portion of the plat.

Similarly, a major remodeling project is planned for Inglemoor High School, with detention provided by 750 LF of 5-foot-diameter pipe. If Alternative M-1 is implemented, the school district should be asked to consider participation in the tightline in lieu of providing the expensive, and ultimately unnecessary, detention.